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**Smith et al.**

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(54) **REMOTE TAPPING METHOD AND SYSTEM FOR INTERNALLY TAPPING A CONDUIT**

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**G08B 21/00** (2006.01)  
(52) **U.S. Cl.** ..... **340/603**; 340/568.2; 340/687; 340/680; 137/315.01; 137/15.08; 137/97  
(58) **Field of Classification Search** ..... 340/603, 340/605, 568.2, 679, 680, 687, 686.2, 686.5; 137/315.01, 317, 318, 15.08, 15.12; 138/97, 138/94

See application file for complete search history.

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*Primary Examiner*—Benjamin C. Lee

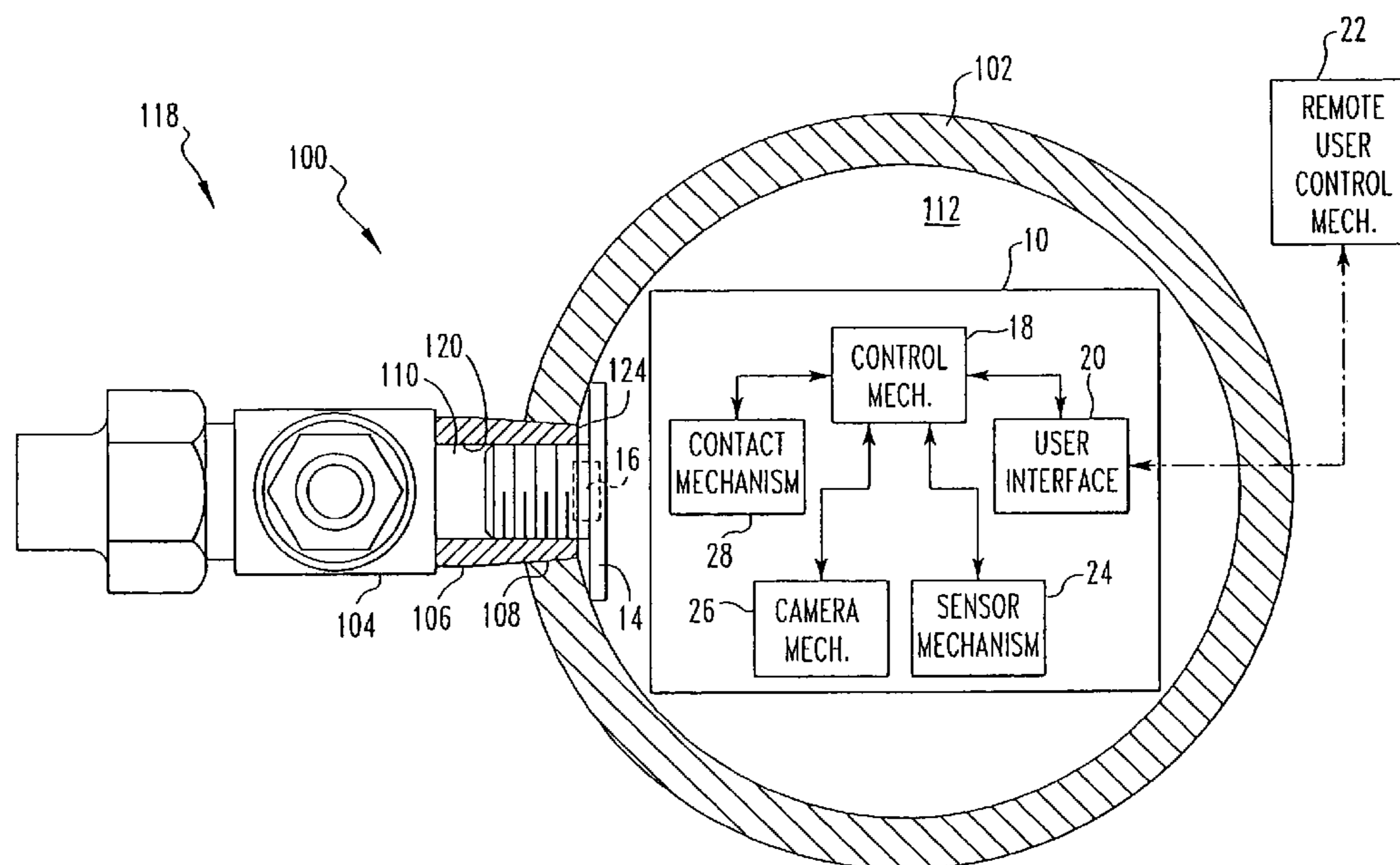
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(57) **ABSTRACT**

Disclosed is a method, system and apparatus for use in remotely and internally tapping a conduit. The method is performed, at least partially, by an automatic mechanism or robot configured to effectively perform the tasks and various steps of the method. The method includes the steps of: (a) lining a conduit with a liner; and (b) inserting an automatic mechanism into an internal portion of the liner, wherein the automatic mechanism (i) locates a service tap connection point; and (ii) at least partially engages a fitting device within an internal surface of the service tap entry portion, thereby providing fluid communication between a service tap internal passageway and an internal portion of the liner. An automatic mechanism, a fitting device and an insert element are also disclosed.

**41 Claims, 8 Drawing Sheets**



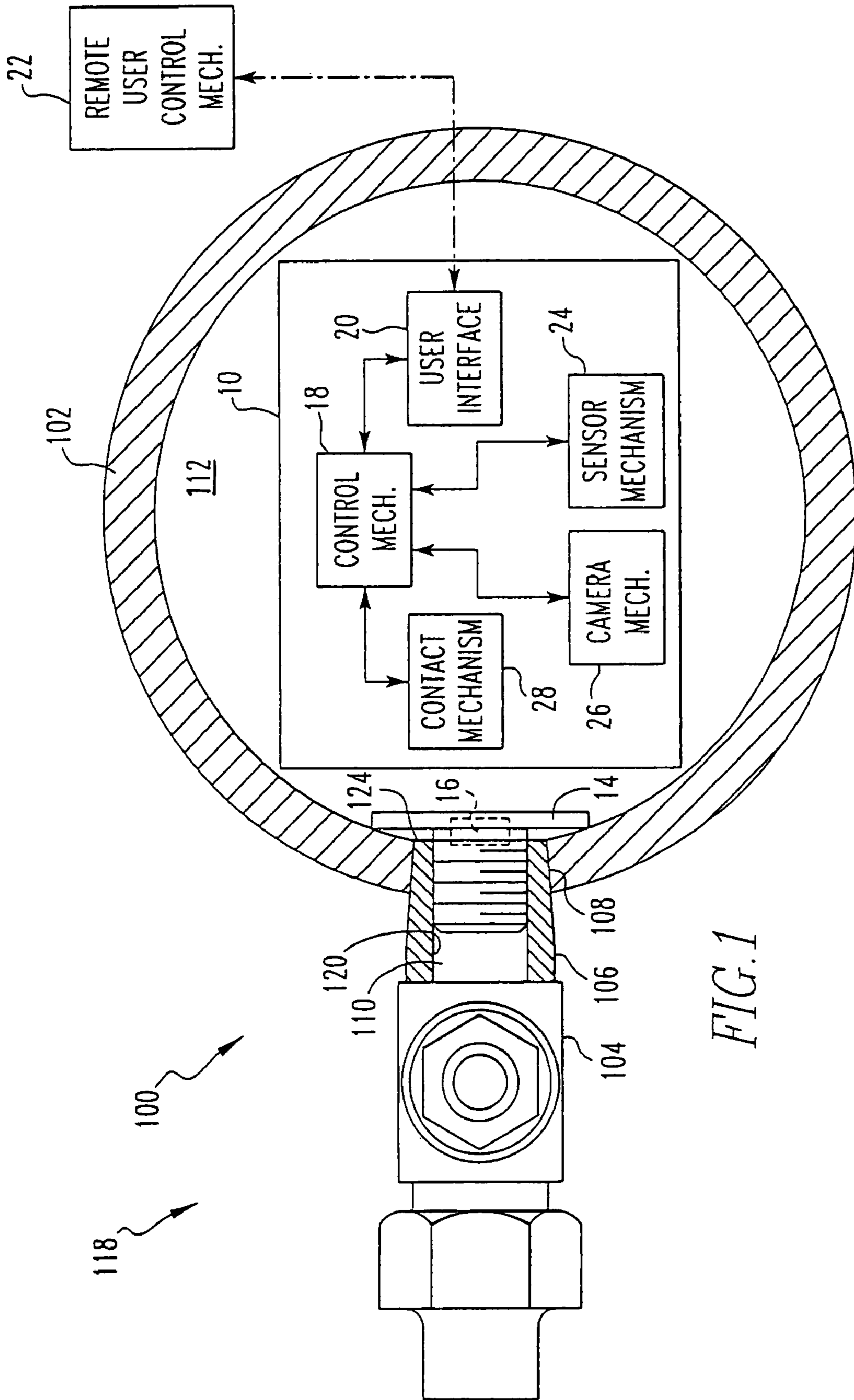


FIG. 1

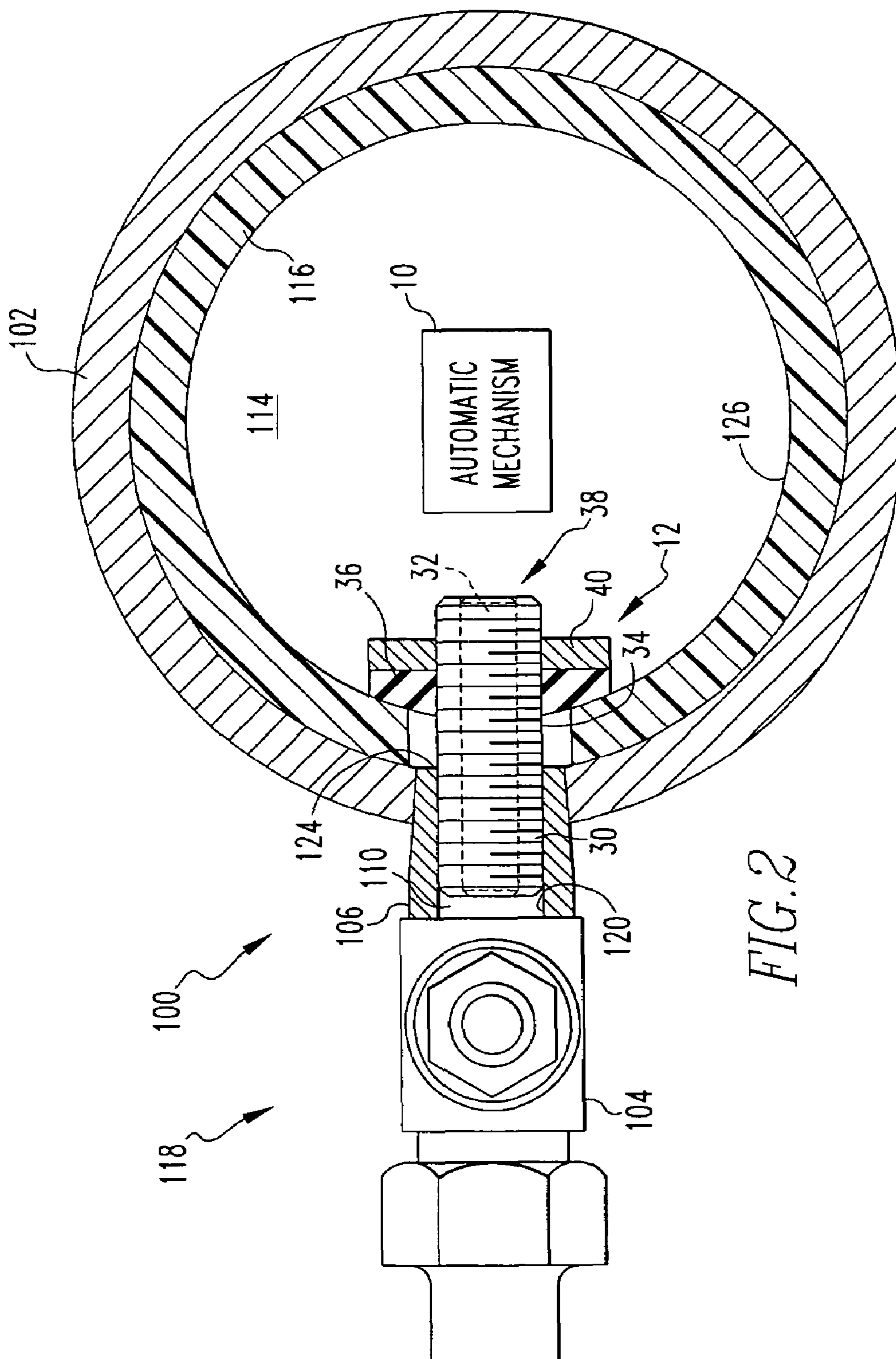


FIG. 2

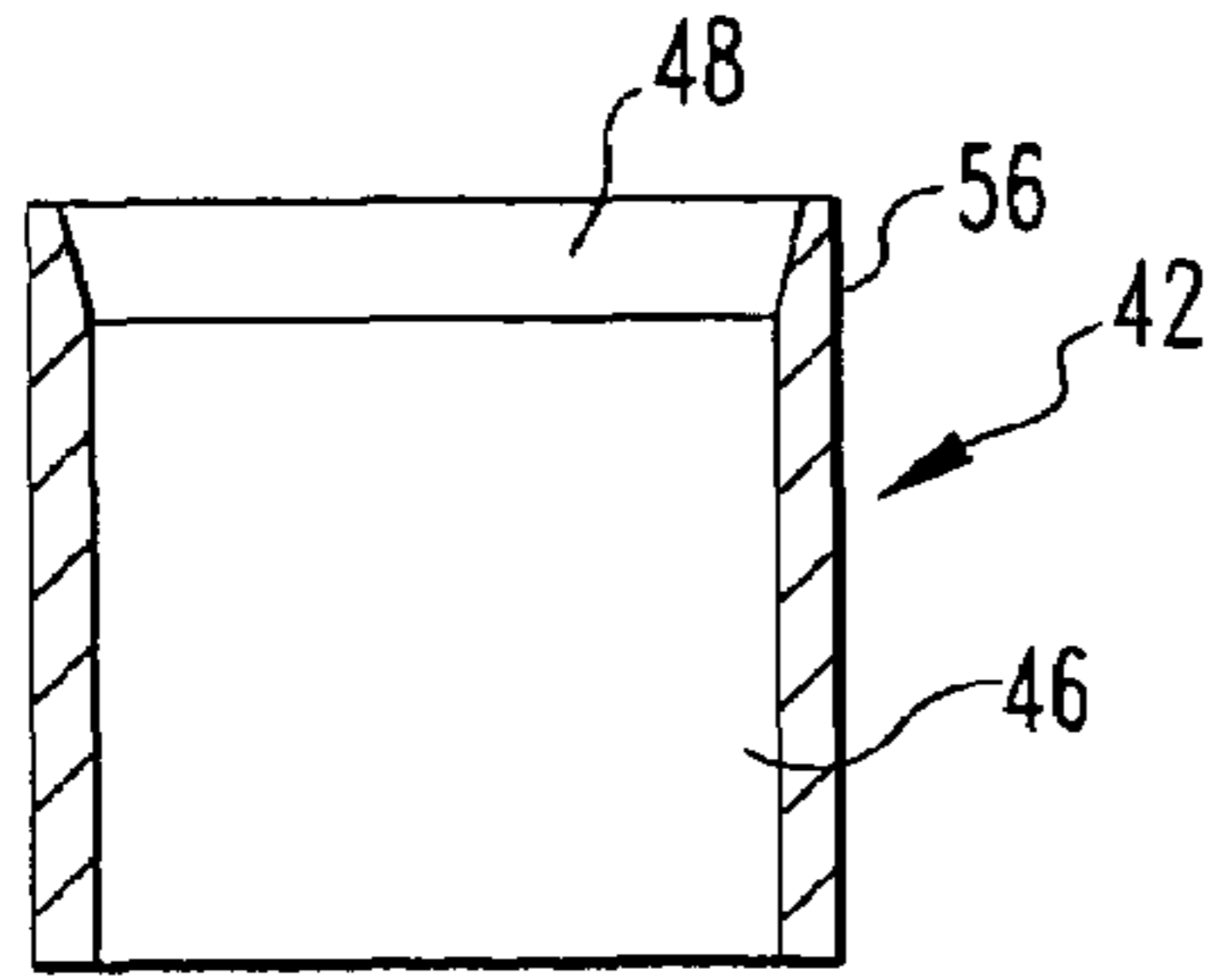


FIG. 3

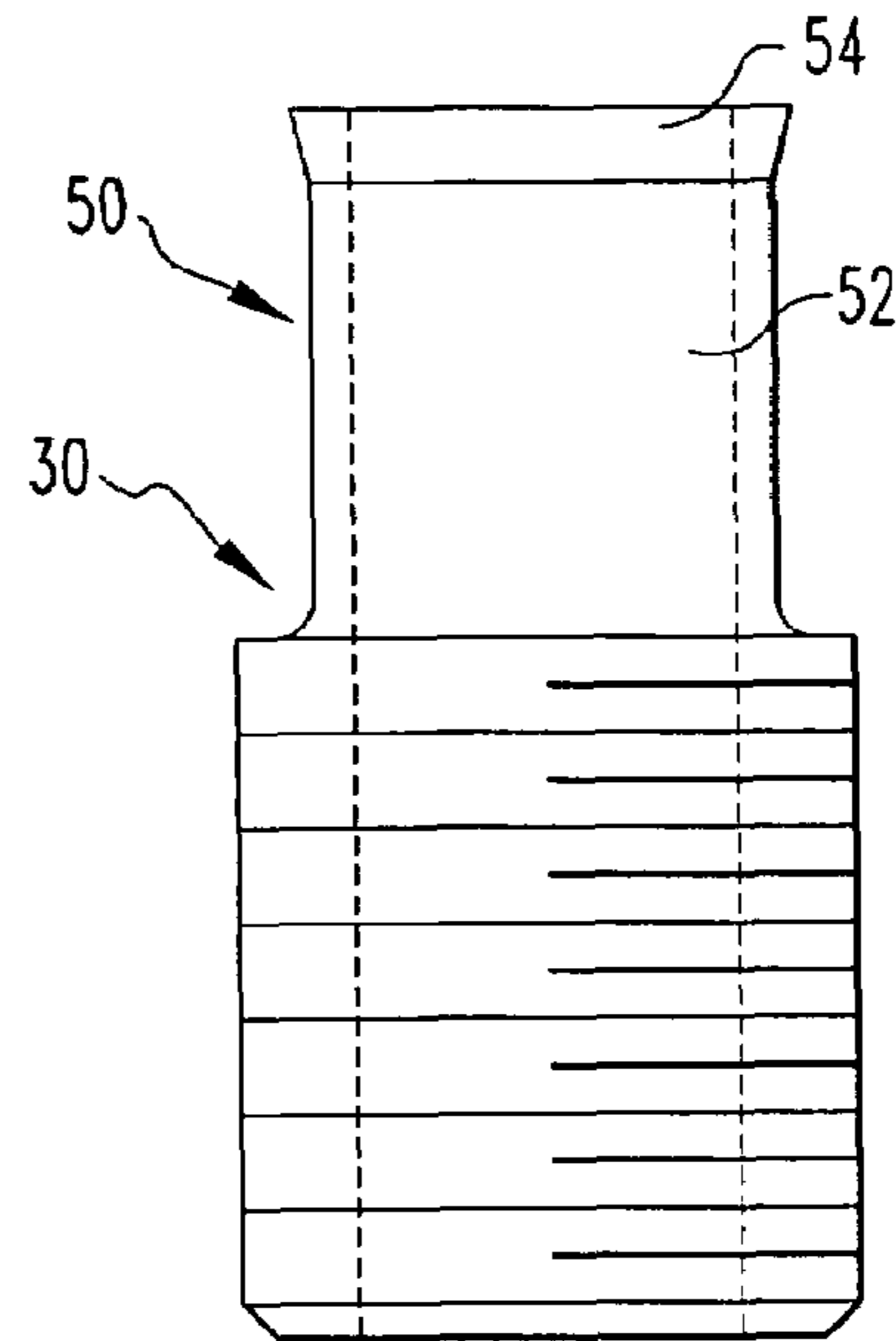


FIG. 4

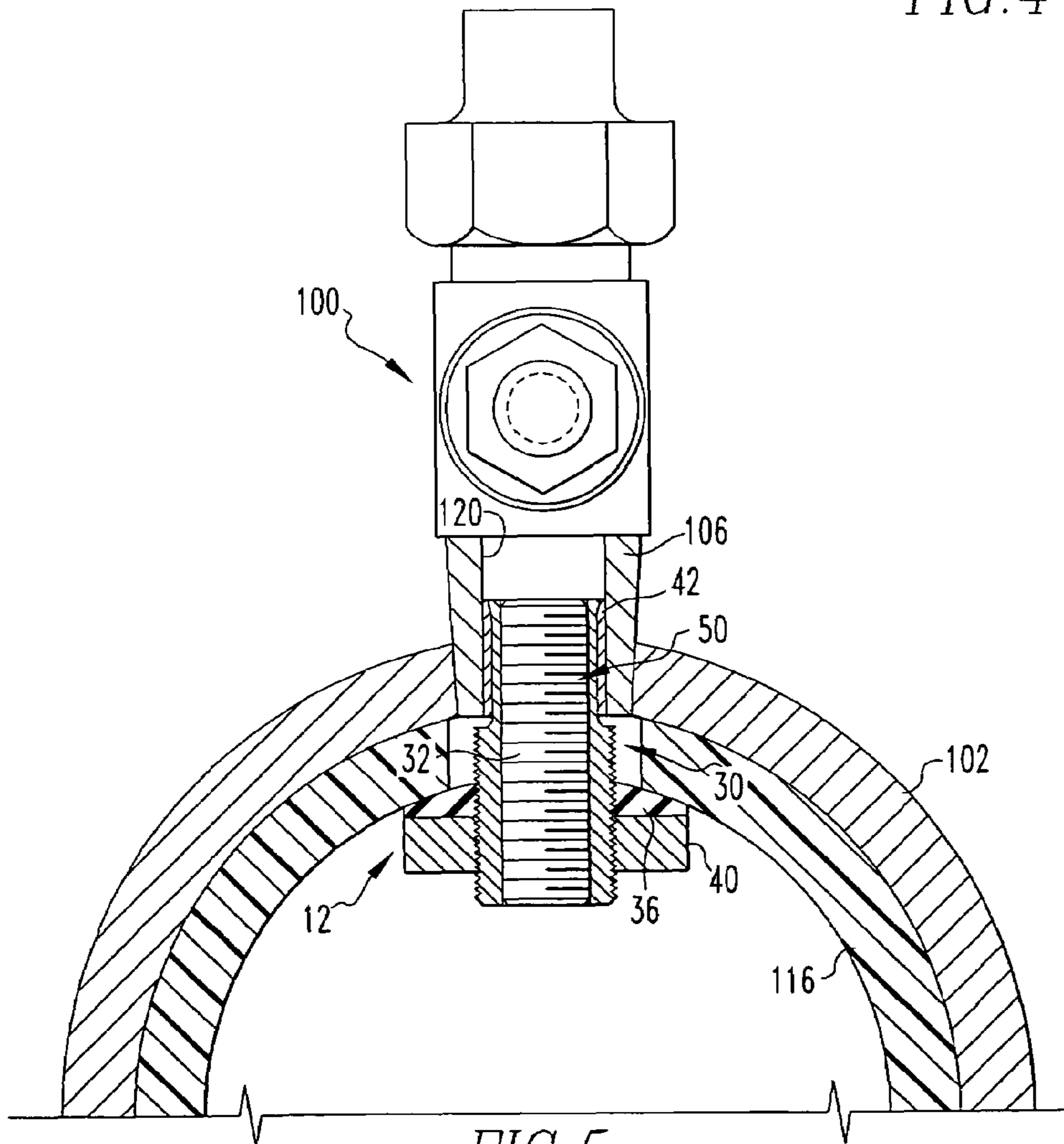
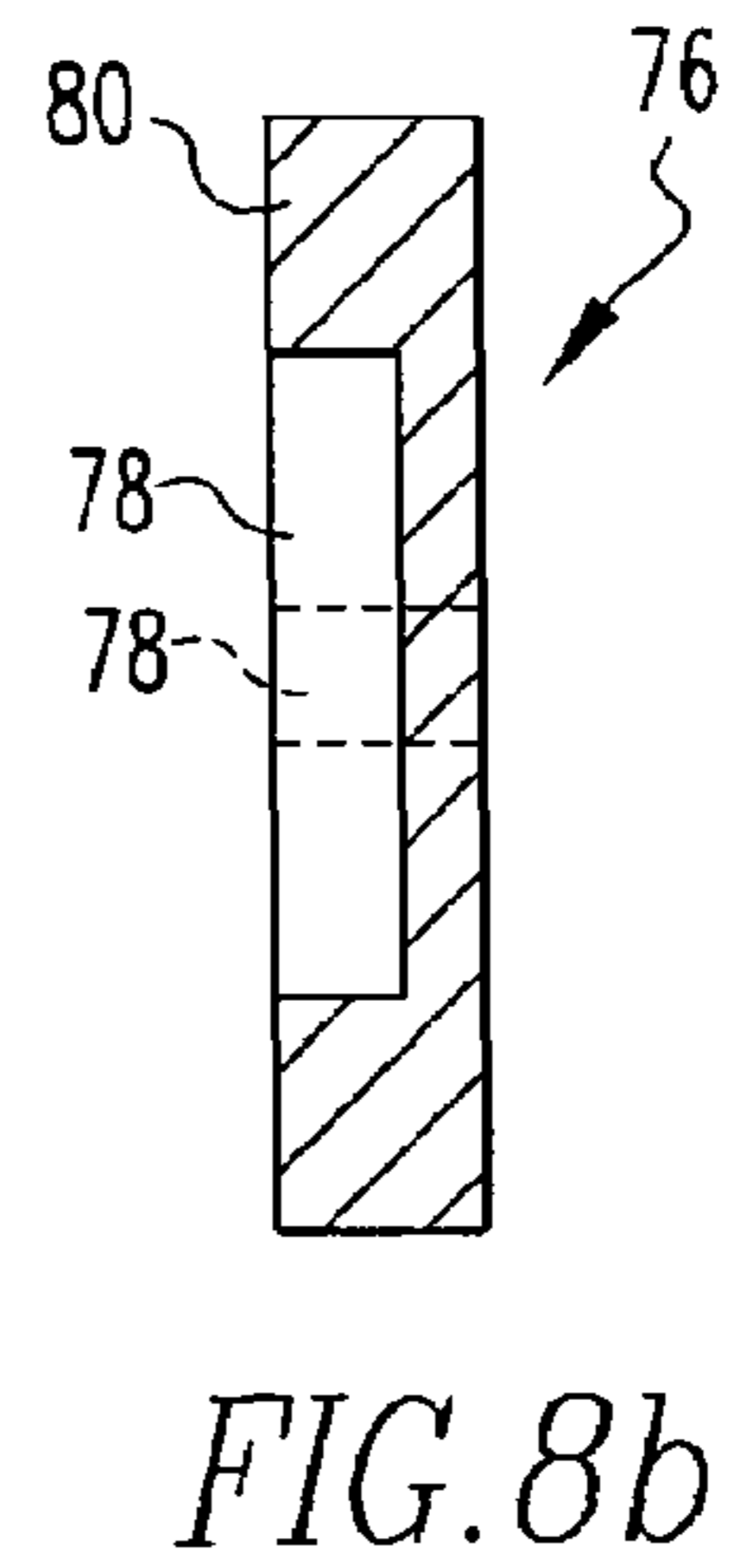
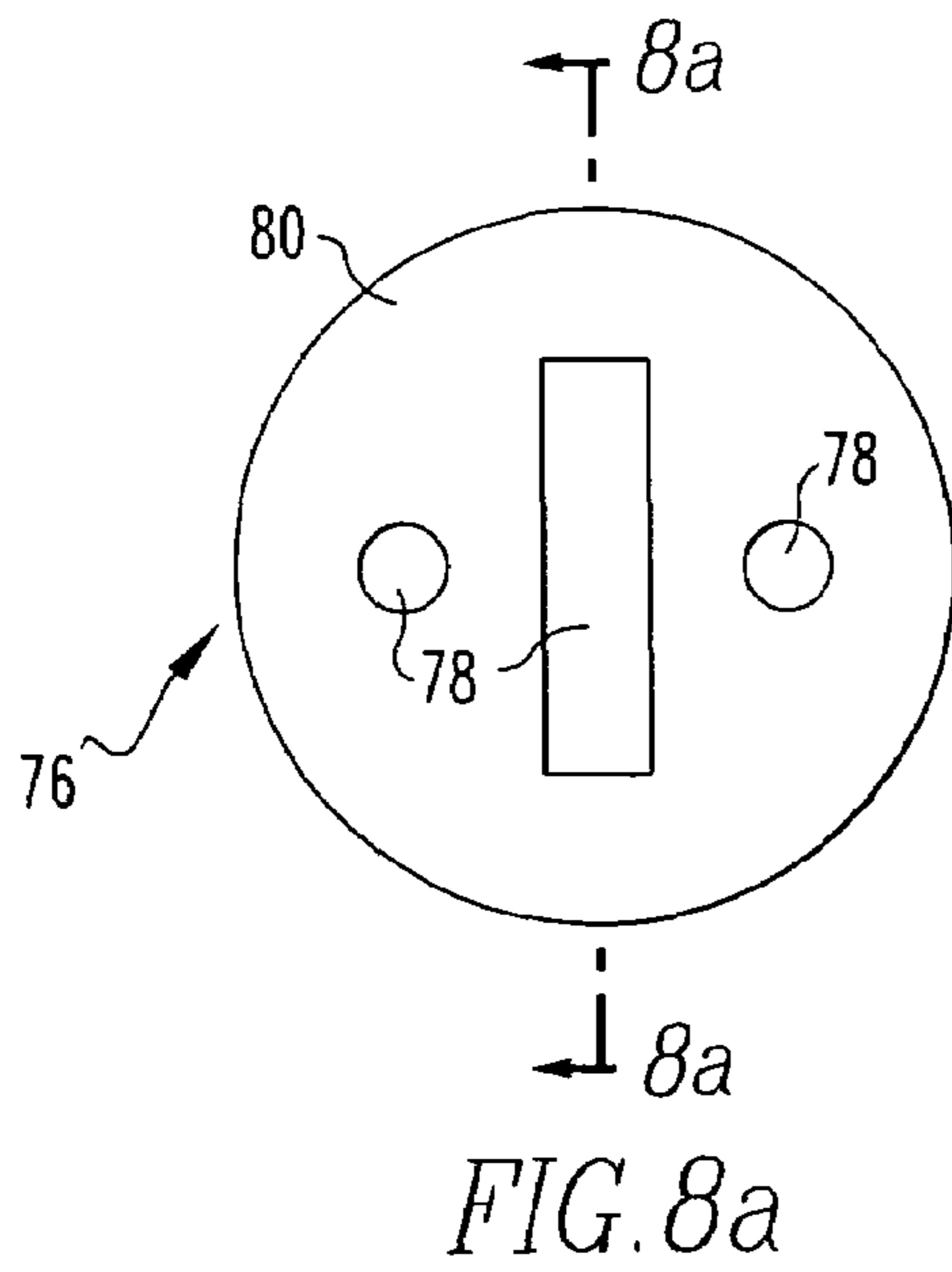
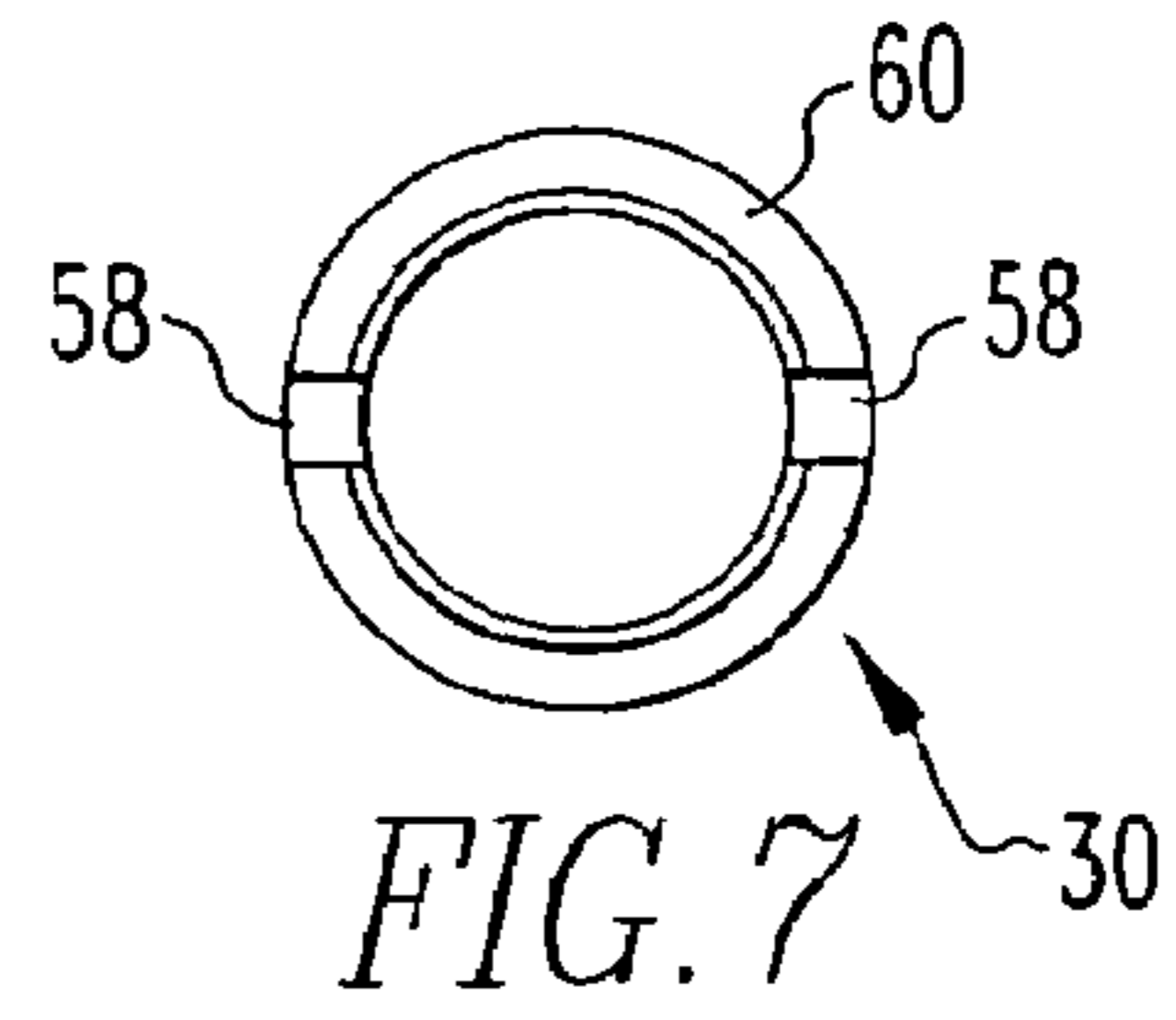
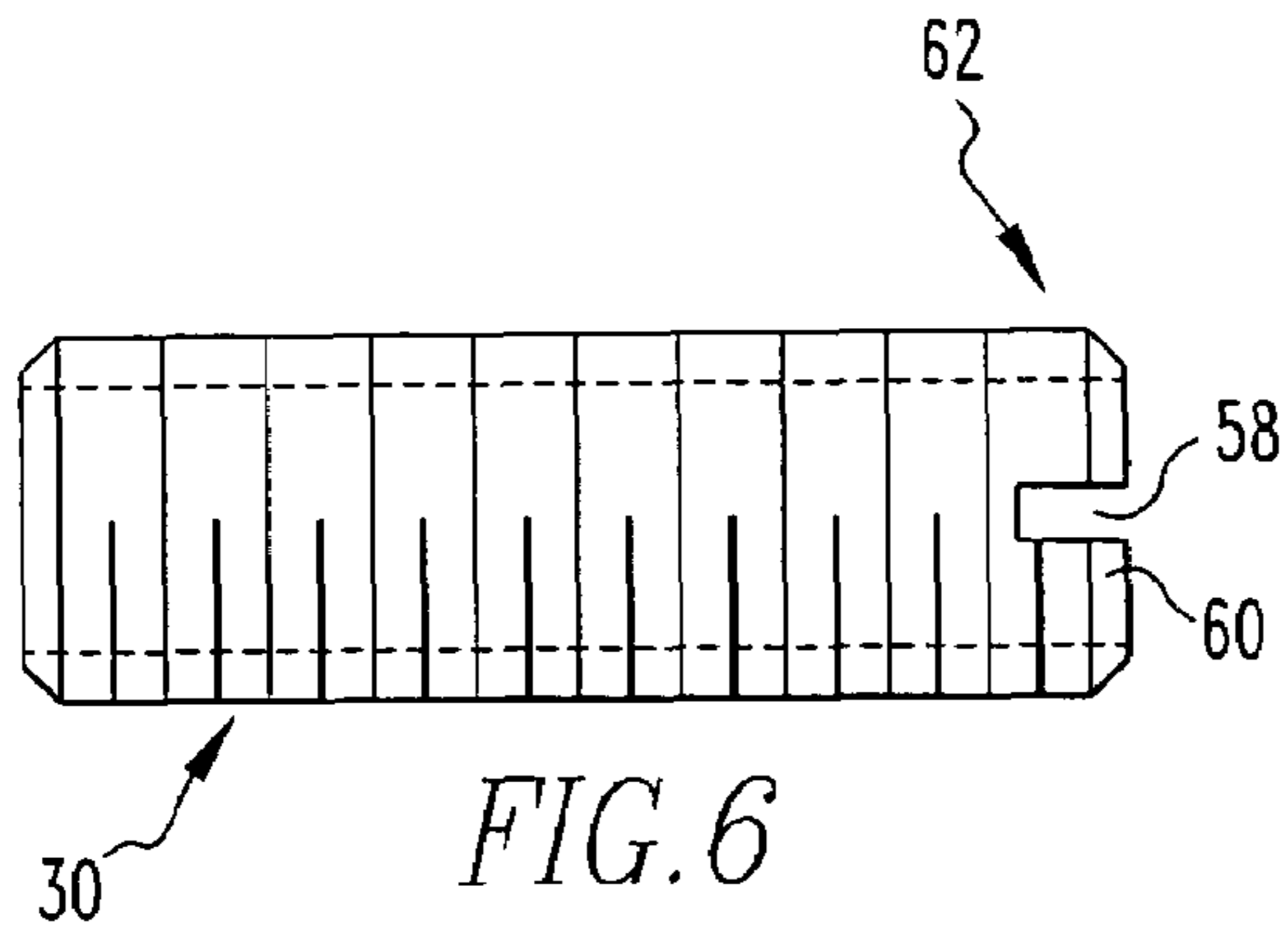


FIG. 5



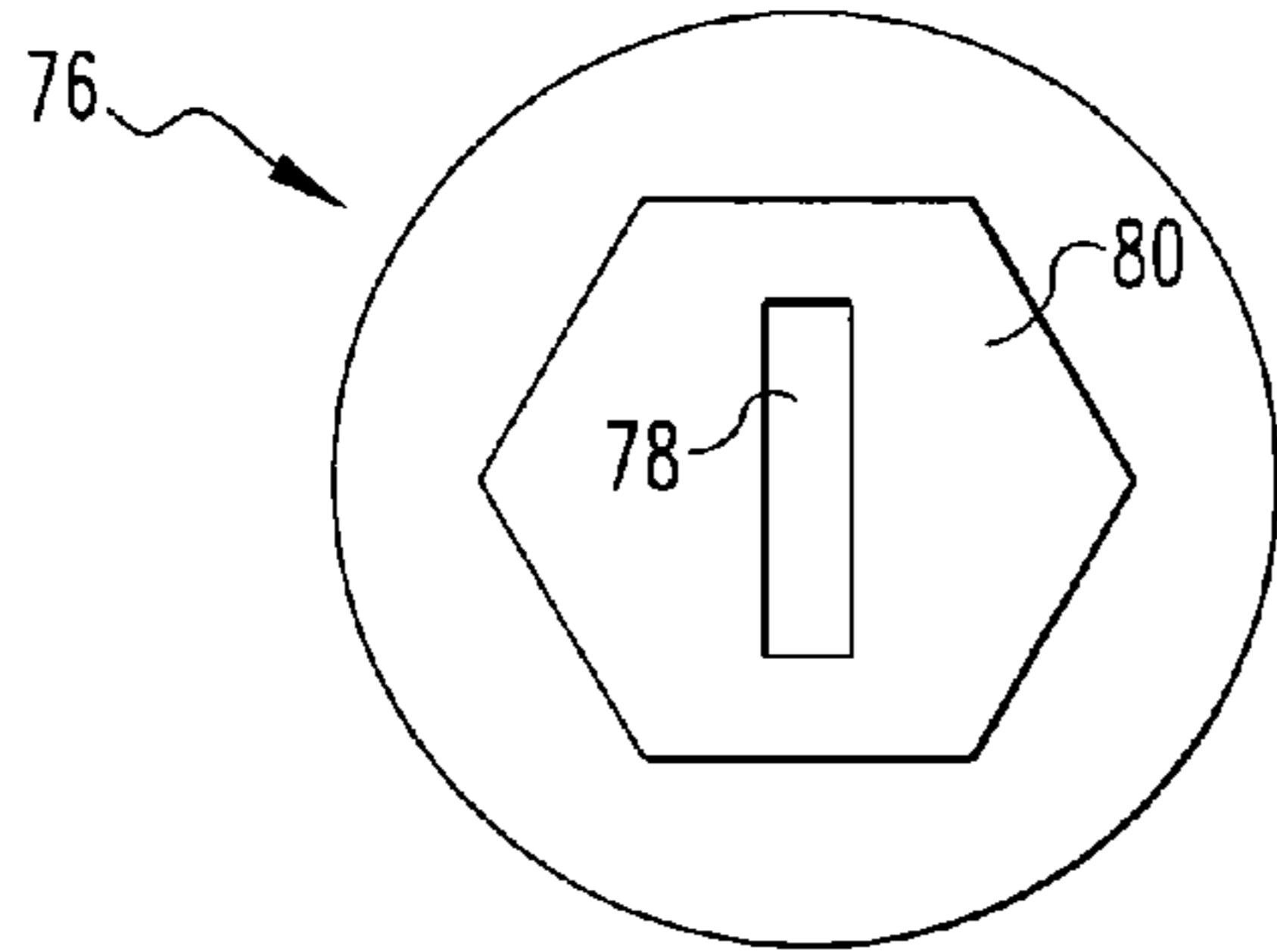


FIG. 8c

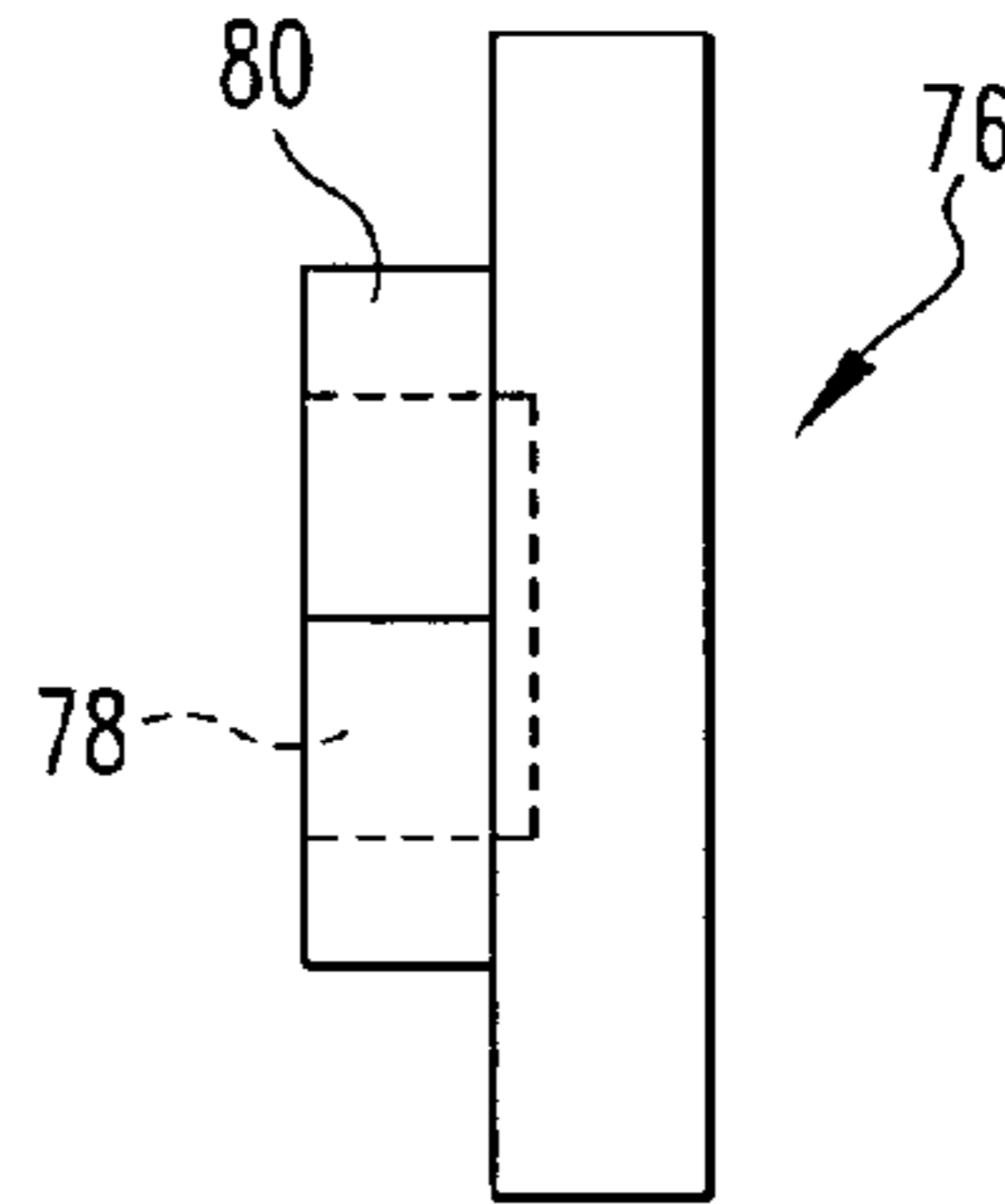


FIG. 8d

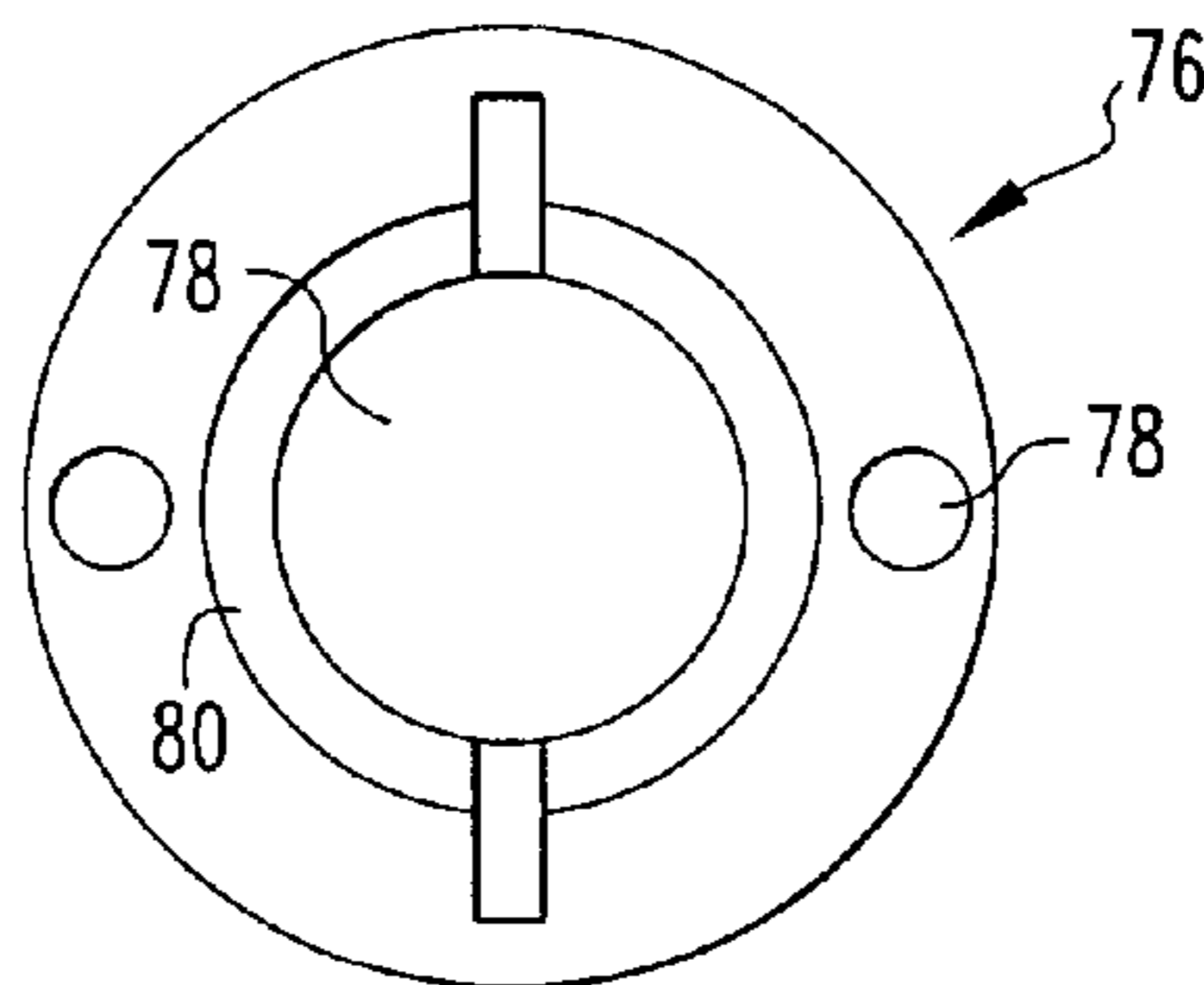


FIG. 8e

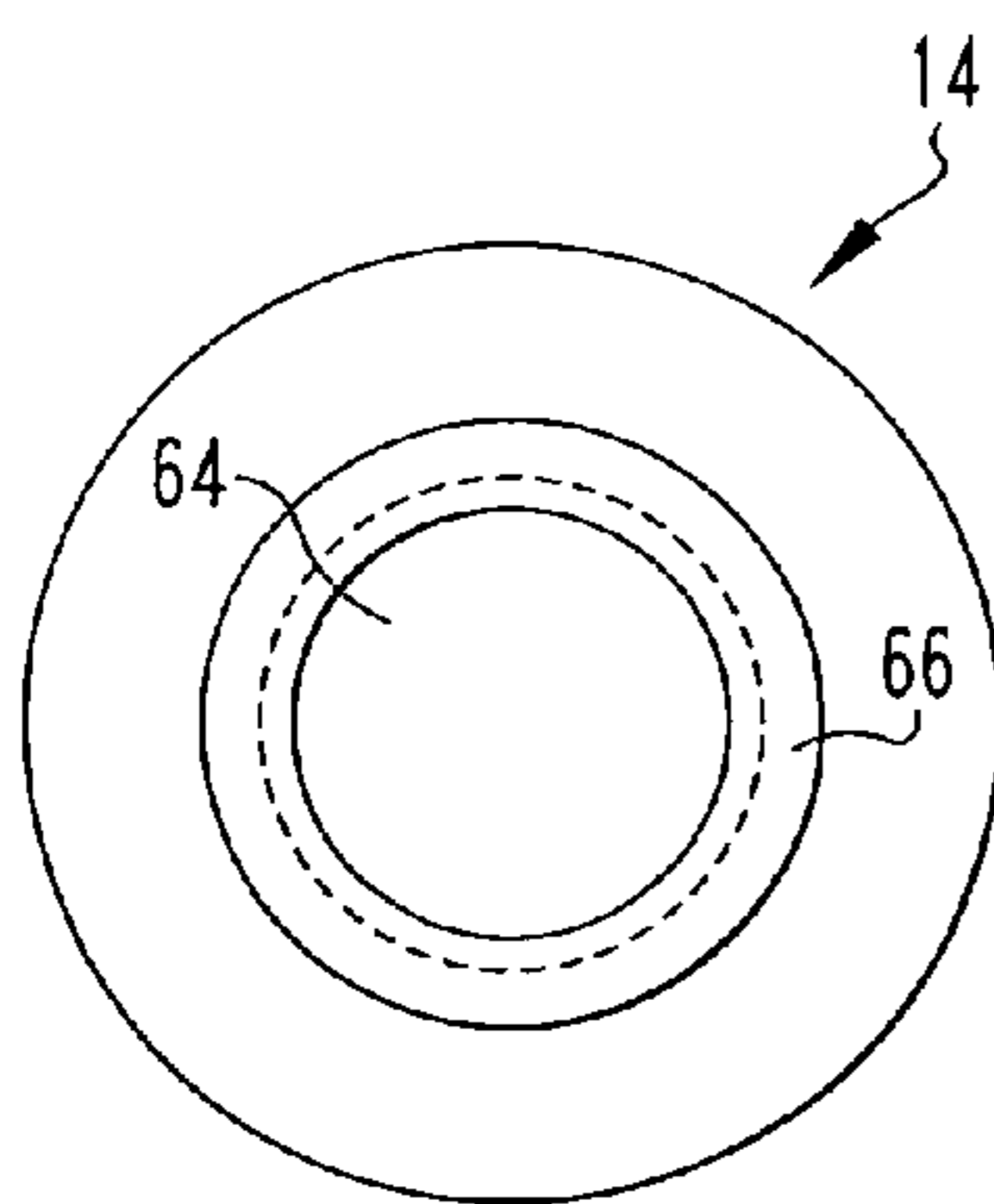


FIG. 10a

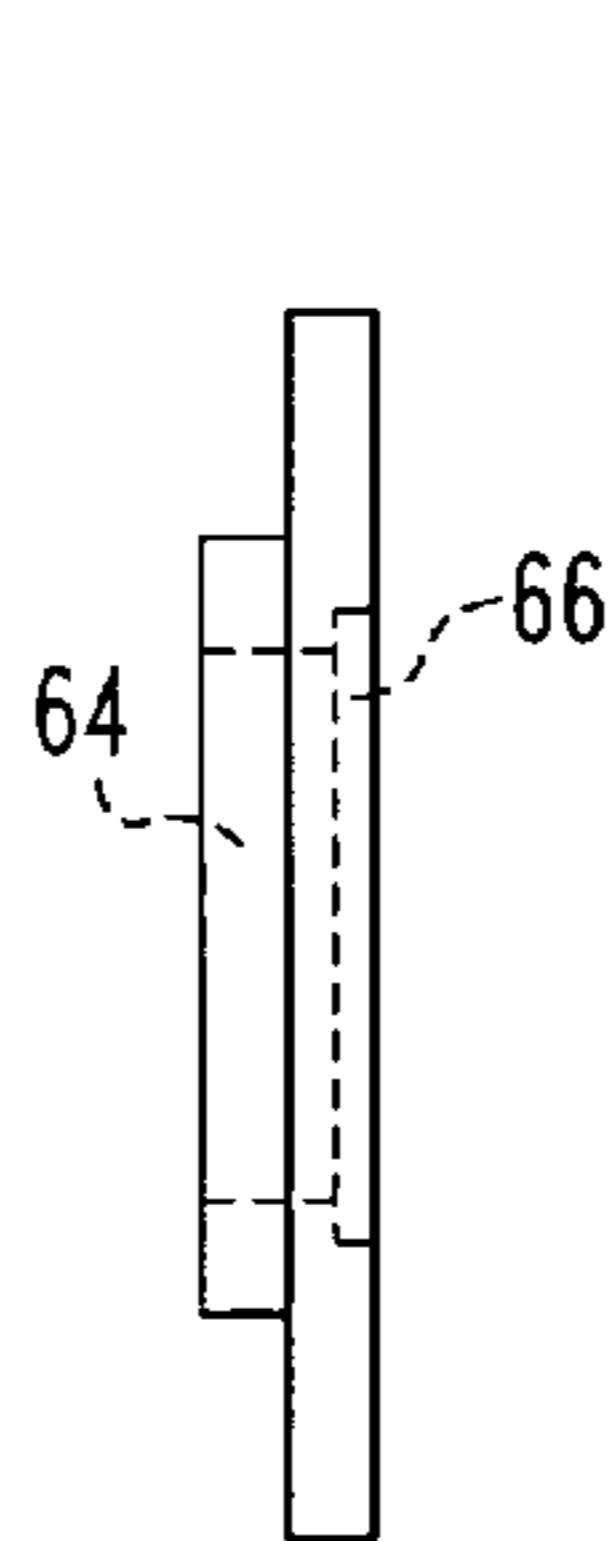


FIG. 10b

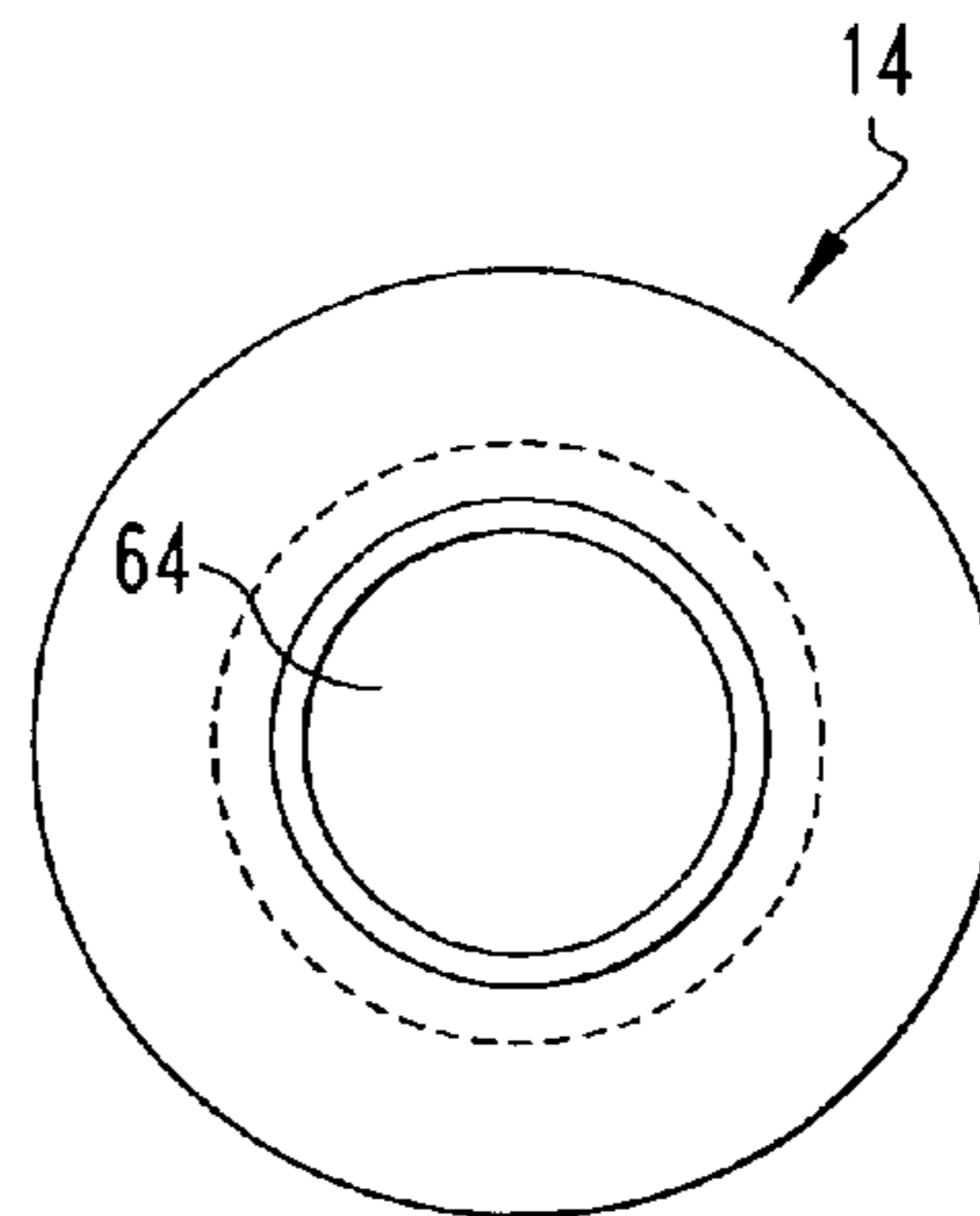
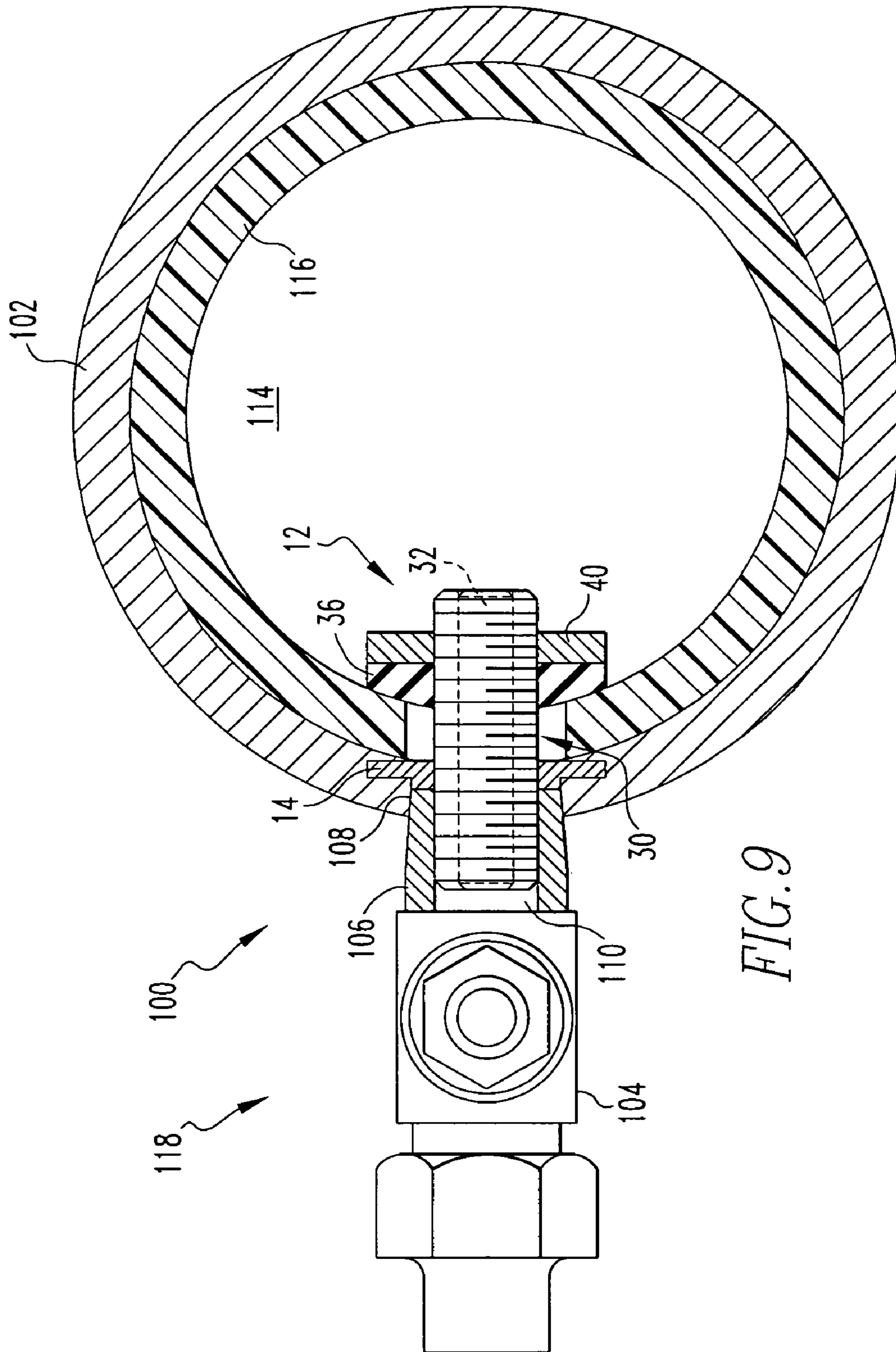


FIG. 10c



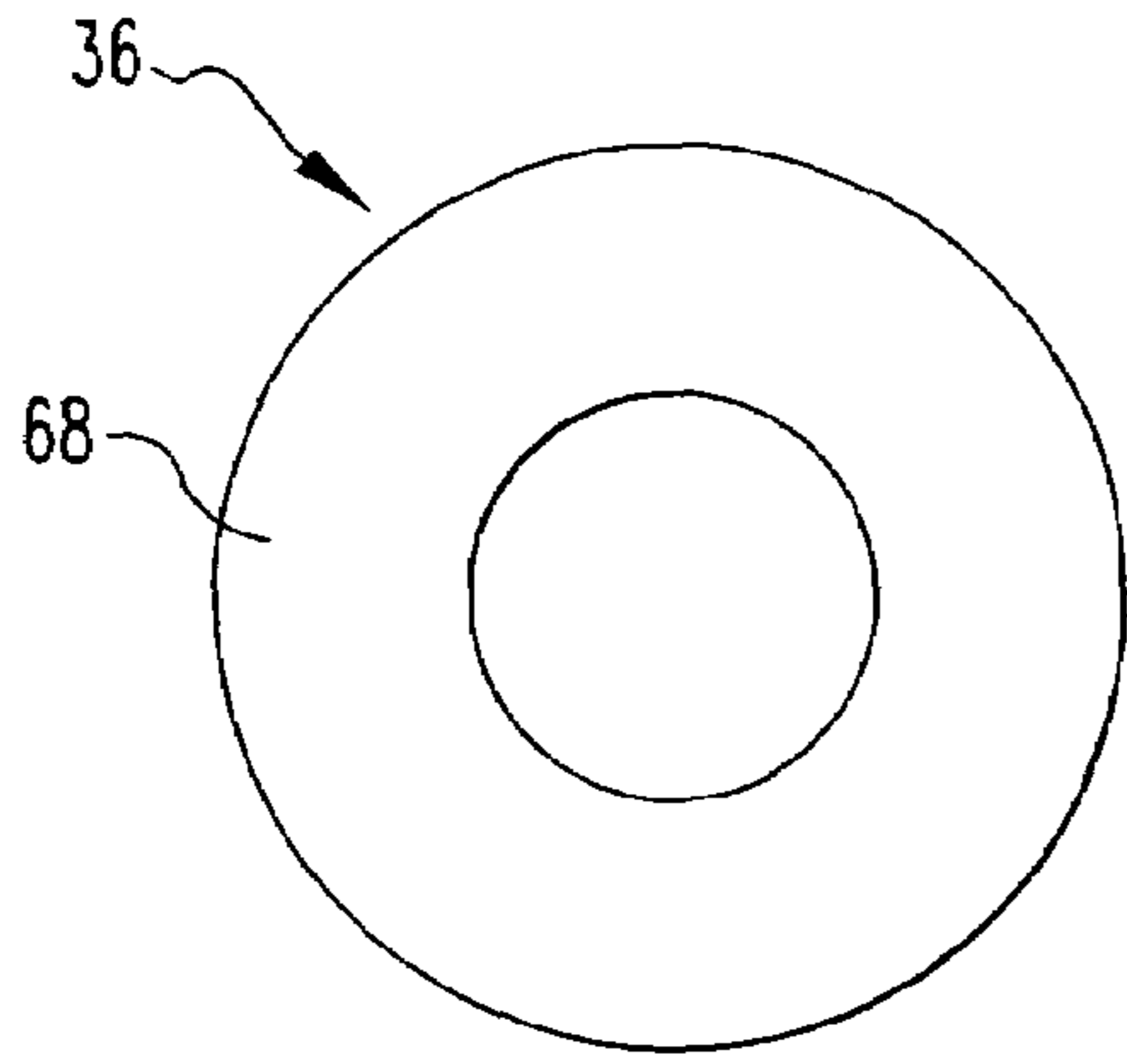


FIG. 11a

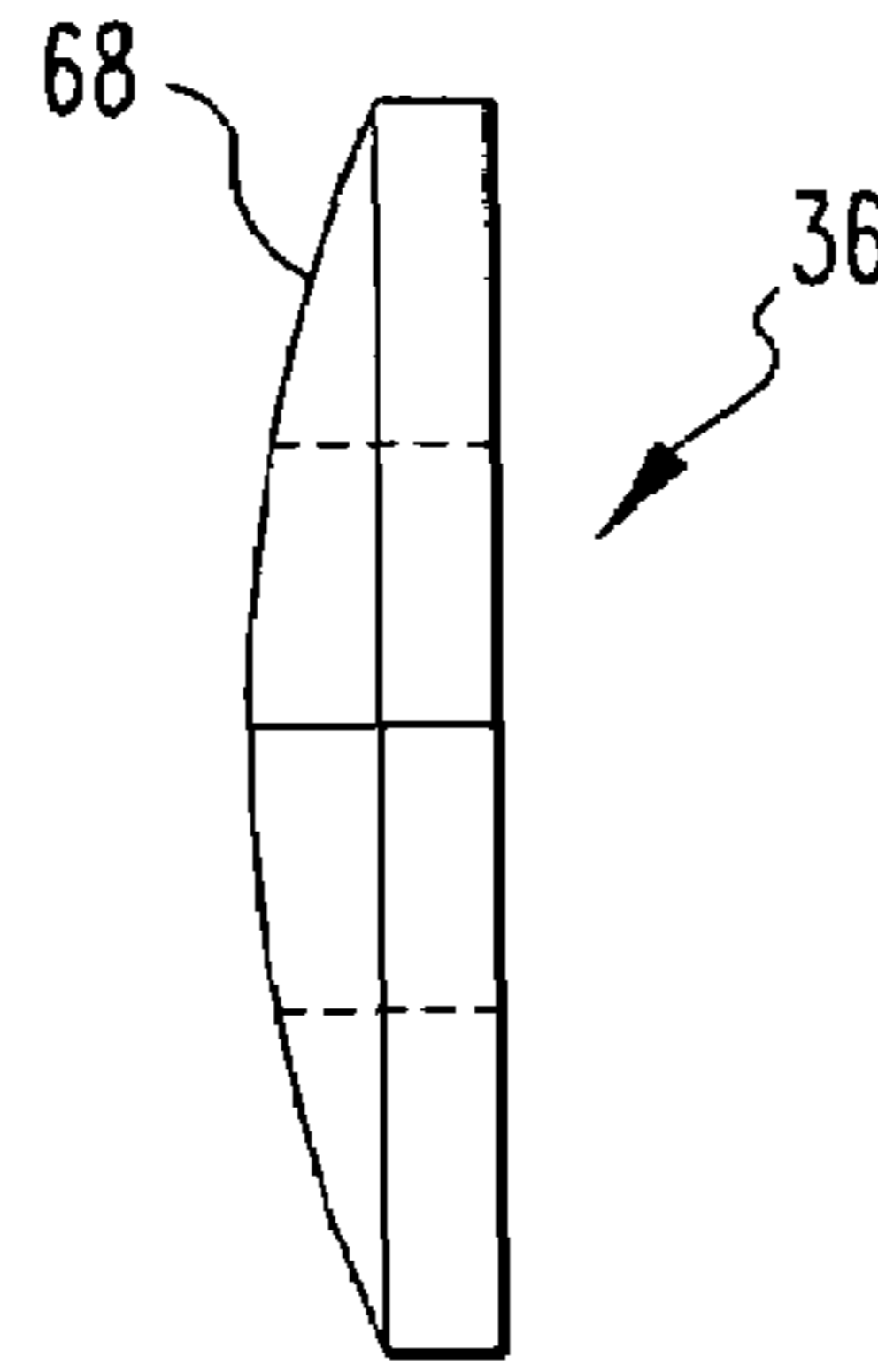


FIG. 11b

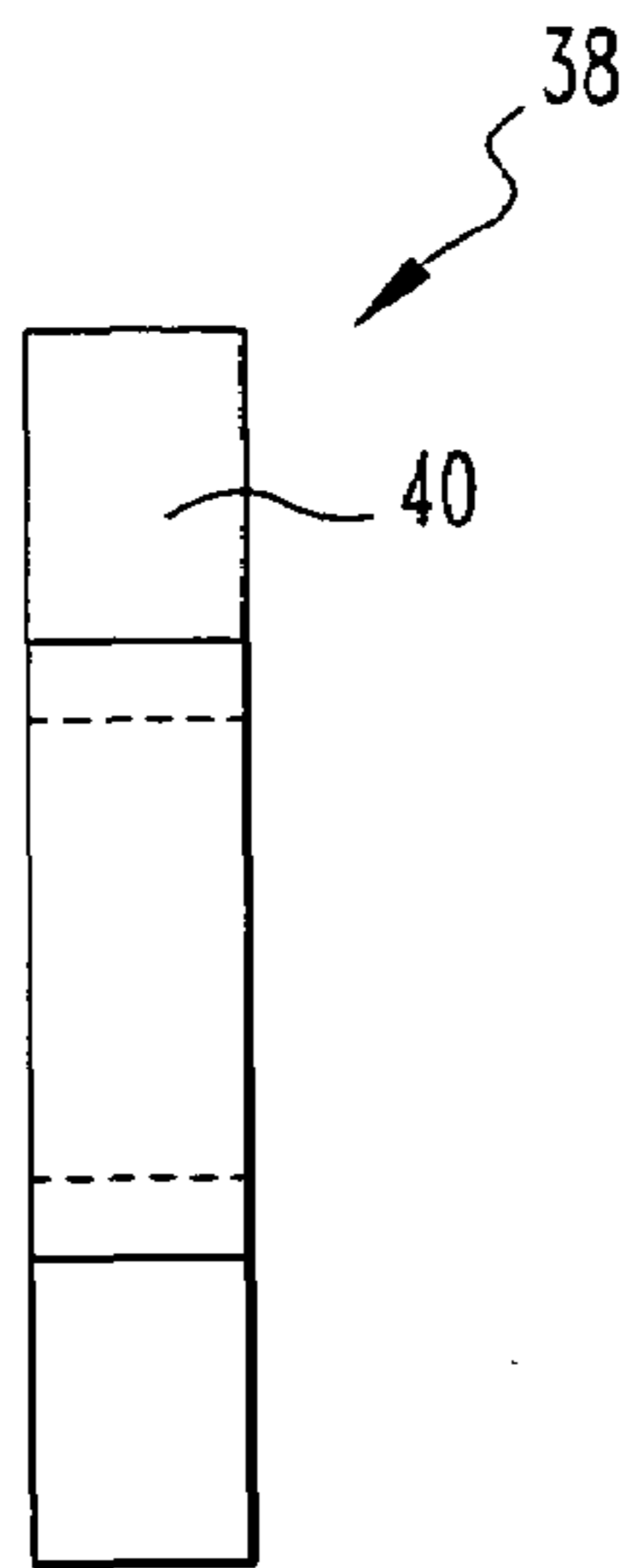


FIG. 12a

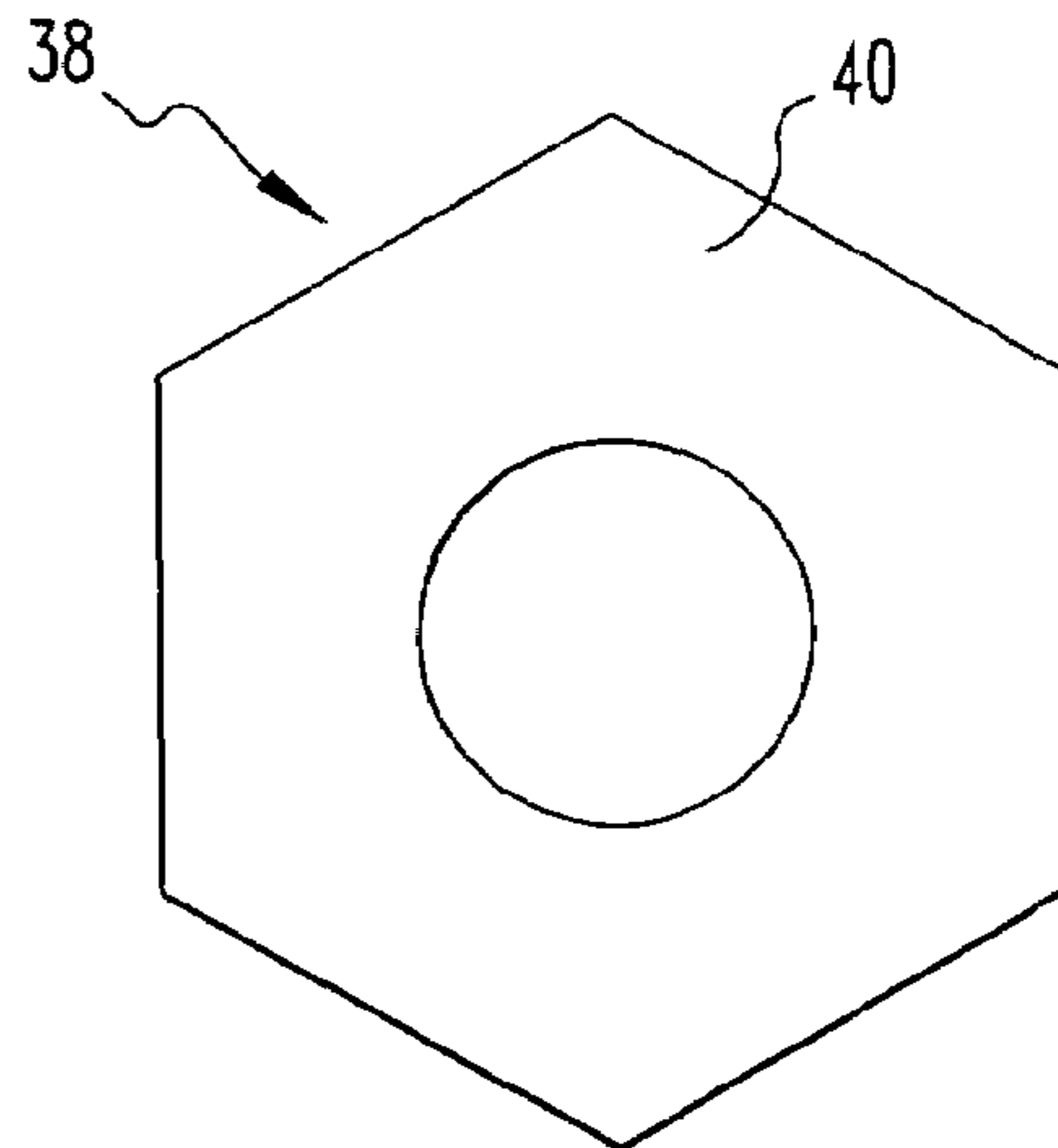
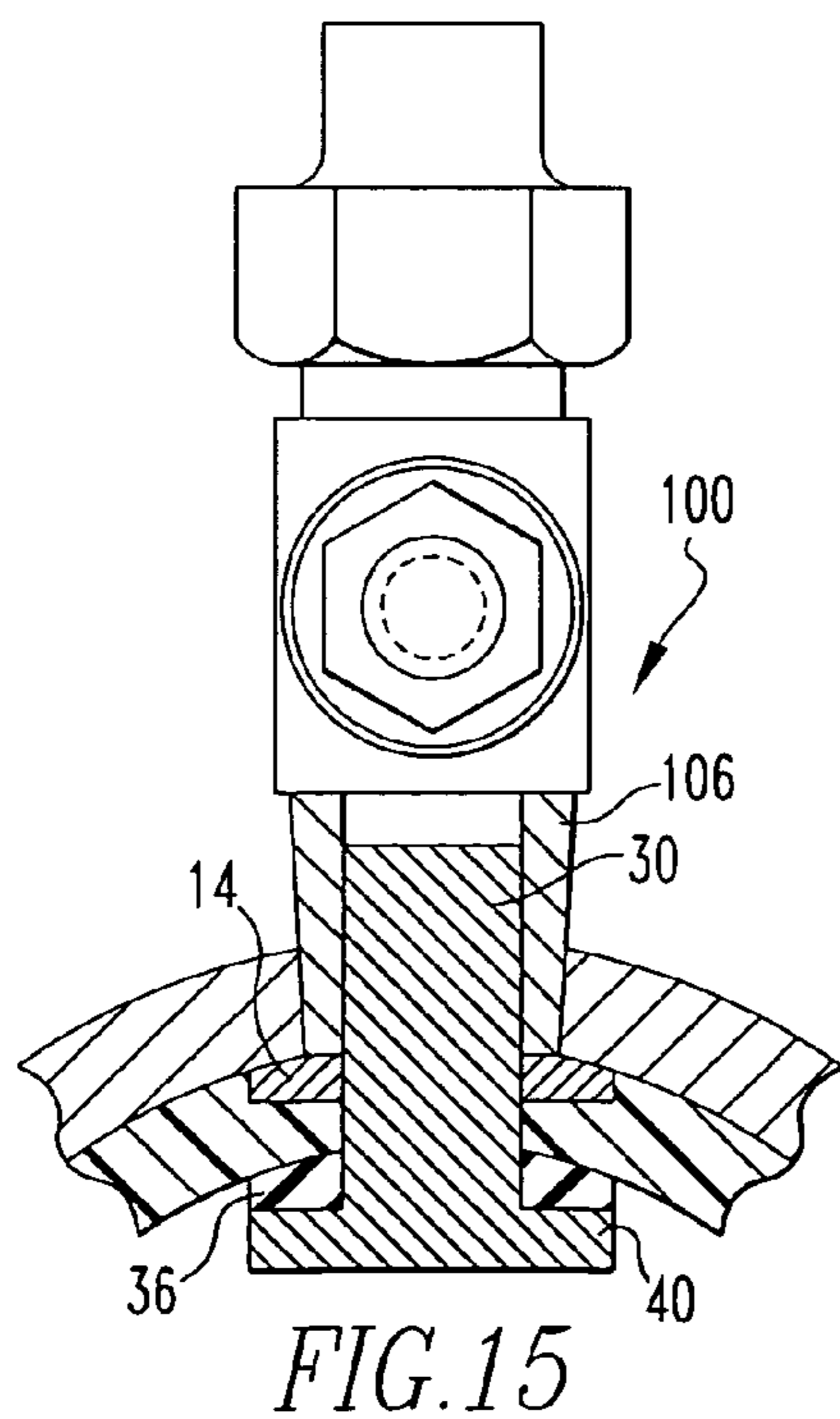
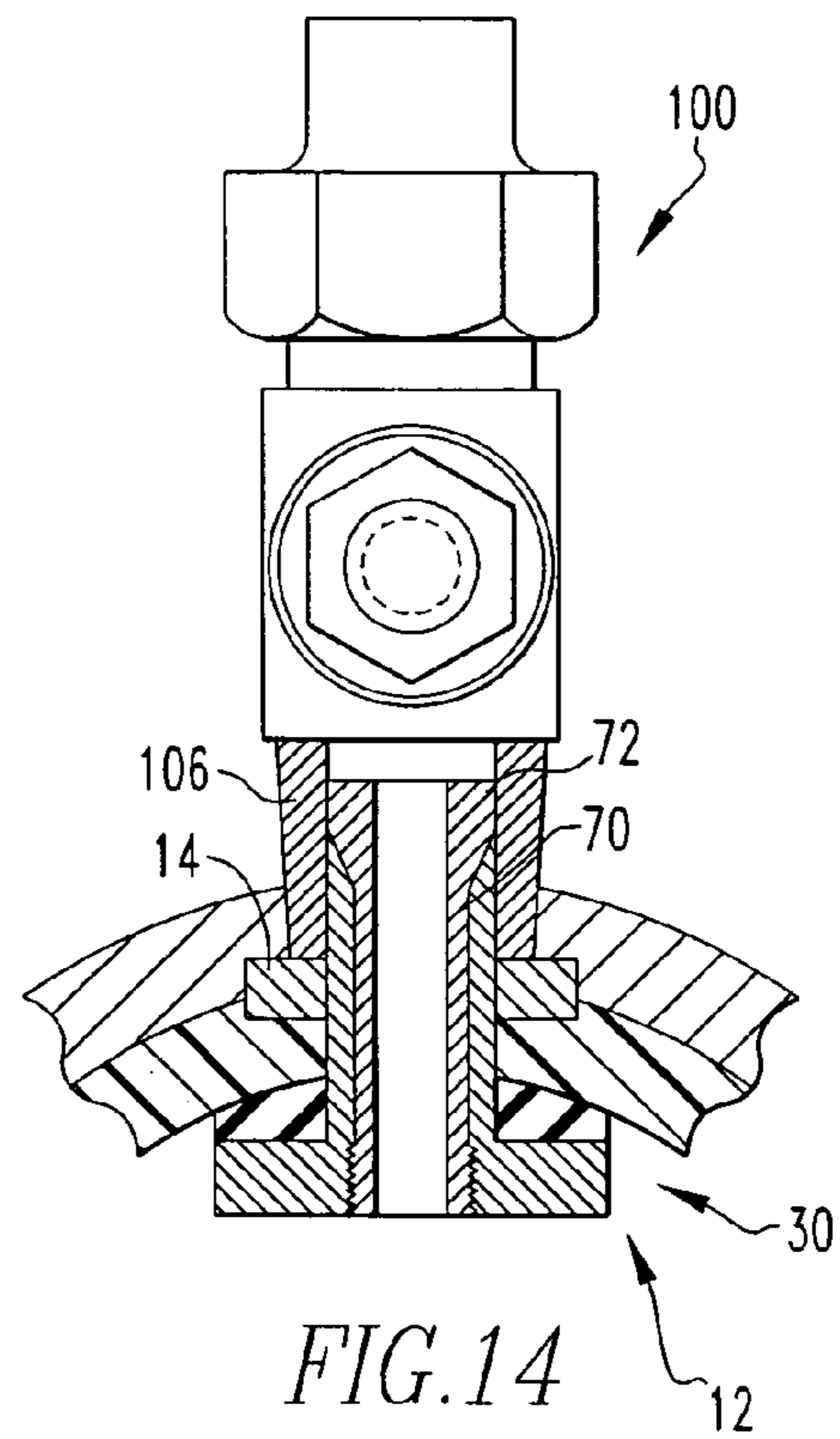
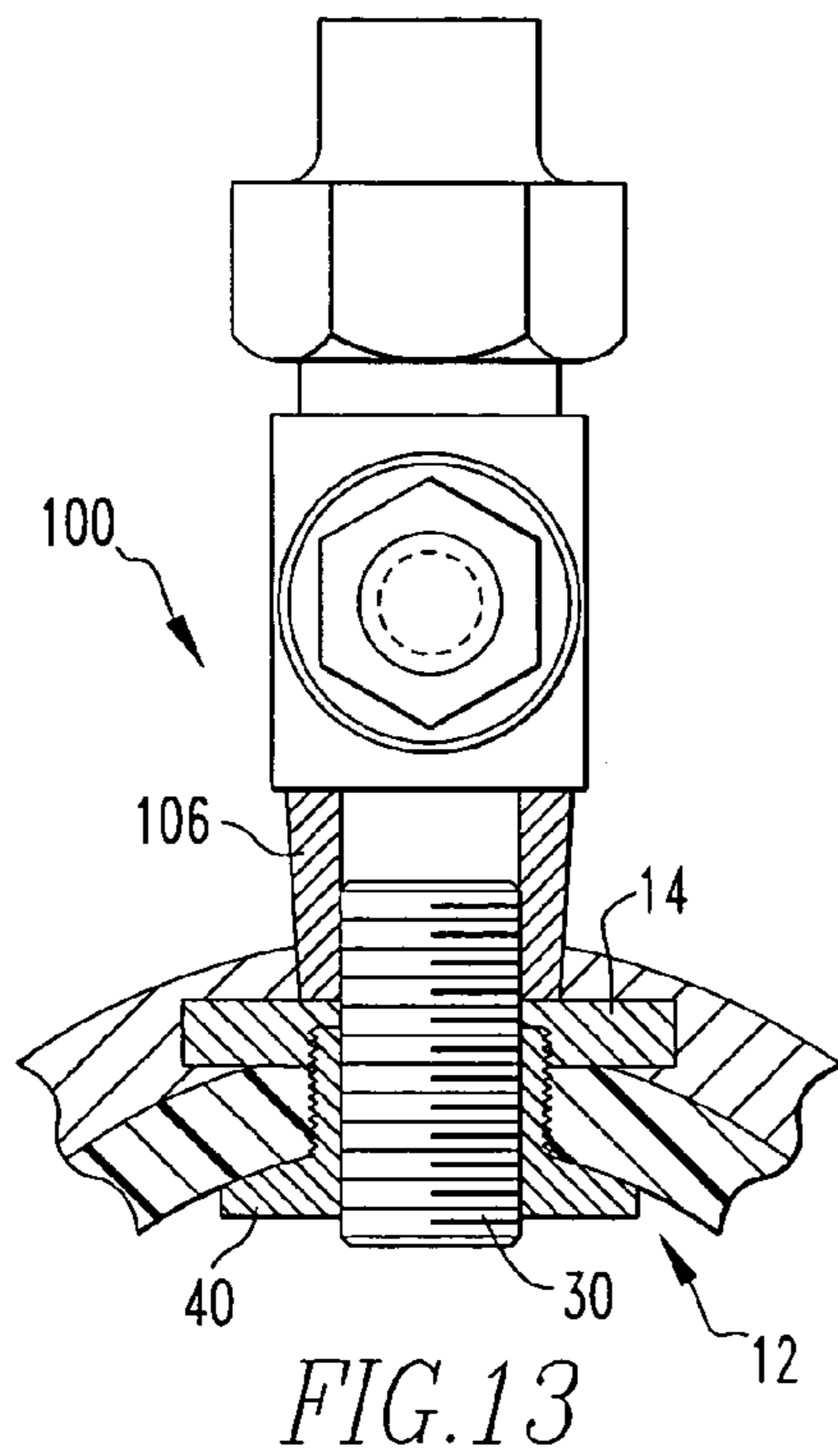


FIG. 12b





## REMOTE TAPPING METHOD AND SYSTEM FOR INTERNALLY TAPPING A CONDUIT

### CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application Ser. No. 60/509,424, filed Oct. 7, 2003, which is herein incorporated by reference in its entirety.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates generally to methods and systems for tapping or connecting a service tap to a conduit, such as a water main, a liner or the like and, in particular, to a remote tapping method and system for internally tapping or reestablishing a tap point for a conduit, such as a host conduit lined with a liner.

#### 2. Description of Related Art

Conduit systems are used extensively throughout the world in order to transfer or convey material, such as water and other fluids, from location to location for distribution throughout the system. For example, extensive conduit systems are used to distribute water to both residences and businesses for use and further processes. Typically, such conduit or piping systems are located underground, as aboveground piping would be both unsightly and intrusive.

Typical water conduit systems transport material through pipe, e.g., cast iron, ductile iron, reinforced concrete, cement-asbestos, etc., buried underground with the branches extending in various directions in order to reach the end user. Normally, after many years of use, or for some other reason, the present piping fails and begins to leak, thereby reducing line pressure and unnecessarily allowing water to leak into the area surrounding the piping. Such leaks not only affect the system but increase the processing costs of the supplier, which, in turn, increases the end user costs. Therefore, these leaks must be quickly repaired and preventative measures taken to ensure that further leakage is prevented.

Due to the underground positioning of the conduit system, repairing a leaking pipe is particularly labor intensive and time consuming. Trenches must be dug along the pipeline to locate the leak and effectively repair it prior to putting the pipe back in service. Various lining systems have been developed according to the prior art in an attempt to seal a leaking pipe or a pipe that has fallen into disrepair, whether to repair a present crack or to preventatively ensure against future cracks or breaks. In addition, the use of a much smaller diameter pipe within the larger diameter cracked or broken pipe has been used. However, this merely replaces the problem of a cracked outer pipe with a cracked or otherwise leaking inner pipe. Still further, using such a pipe-in-pipe system drastically reduces the flow through the conduit system and evidences unwanted and varying pressure parameters.

To that end, a pipe liner and method of installation have been developed, as disclosed in U.S. Pat. No. 5,794,662 to St. Onge et al., specifically directed to pressurized pipeline applications. The St. Onge patent is directed to a method of relining sewer lines, water lines or gas lines, and uses a segmented liner of reduced size relative to the pipe being relined. However, as opposed to merely leaving the small diameter liner conduit within the large diameter outer conduit, the method of the St. Onge patent uses heat and/or pressure to mold the reduced size pipe to the shape of the pipe being relined. In particular, the inner or liner conduit is

a thermoplastic pipe, typically a polyvinyl chloride (PVC) pipe that, when exposed to heat or pressure, expands and molds against the inside of an existing conduit to effect the relining of it. This process allows for both the lining of the entire length of pipe or only a portion of it that is damaged, which is typically referred to as "spot repair."

According to the St. Onge patent, once the length of the liner conduit is inserted into the existing or host conduit, the liner conduit is plugged at either end and exposed to steam under pressure to heat the liner conduit along its length and apply pressure which urges it to expand and contact the interior walls of the surrounding host conduit. Once the liner conduit has fully expanded to conform to the interior surface of the existing conduit, it is cooled and the plugs are removed. The resulting expanded liner conduit conforms to the walls of the host conduit, thereby preventing any further leakage. Also, the method of the St. Onge patent requires only trenches to be dug at either end of the section to be repaired.

While the St. Onge patent represents an advance in the art of relining or repairing underground conduit systems, there is room in the art for additional improvements and advancements. When initially constructing a water main conduit in a trench, the conduit is fitted with various service taps along its length. These service taps are used to draw water from the main conduit and provide controlled flow through a service conduit or line to a dwelling, business, site, property, etc. After the service taps are positioned and integrated with the main conduit, and the service conduits are attached thereto, the exposed water main is covered and the trench filled in.

A drawback in the art presents itself when, after the host conduit is lined with the liner conduit, as discussed above or in any "lining" method and system as is known in the art, the liner is now blocking the service taps. In order to reestablish the service tap entrance to the water main conduit, another trench must be excavated to access the service tap and allow a subsequent tap entrance to be formed through the liner or liner conduit. This represents a large undertaking, in that, in any given length of the water main, multiple service taps are present, such that great lengths of the water main must be excavated and exposed in order to reestablish the tap points.

### SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a remote tapping method and system for internally tapping a conduit that overcomes the deficiencies of the prior art. It is another object of the present invention to provide a remote tapping method and system that eliminates the need for excavating a buried conduit in order to position and reestablish service taps. It is a further object of the present invention to provide a remote tapping method and system that can remotely locate a preexisting service tap point for reestablishing a tap point entrance for a service tap. It is yet another object of the present invention to provide an automatic mechanism for remotely tapping one or more service tap connection points on a conduit. It is a further object of the present invention to provide an insert element for use in connection with tapping a service tap connection point on a conduit. It is a further object of the present invention to provide a fitting device for use in connection with tapping a service tap connection point on a conduit.

The present invention is directed to a remote tapping method, system and apparatus for use in connection with a host conduit lining process. The lining process may be an expanded lining process or an unexpanded lining process. The method is performed, at least partially, by an automatic

mechanism, such as a robotic mechanism, that is configured to effectively perform the tasks and various steps of the method. In particular, the present invention is directed to a method for remotely tapping at least one service tap connection point on a conduit, wherein the connection point includes a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway.

It one preferred and non-limiting embodiment, the method includes the steps of: (a) lining the conduit with a liner; and (b) inserting an automatic mechanism into an internal portion of the liner, wherein the automatic mechanism: (i) locates the service tap connection point; and (ii) at least partially engages a fitting device with the internal surface of the service tap entry point portion, thereby providing fluid communication between the service tap passageway and the internal portion of the liner. In a further embodiment, prior to step (a), the method further comprises the steps of: inserting the automatic mechanism into the internal portion of the conduit; wherein the automatic mechanism: (i) locates the service tap connection point on the conduit; and (ii) engages at least a portion of an insert element, which is in operable communication with a sensing target element, with the internal surface of the service tap entry portion; and removing the automatic mechanism from the conduit. In this embodiment, the automatic mechanism may locate the service tap connection point utilizing the sensing target element.

The present invention is also directed to an automatic mechanism for remotely tapping a service tap connection point on a conduit. The automatic mechanism is configured to perform one or more of the following steps: (i) locate the service tap connection point on the conduit; (ii) prepare an internal surface of the service tap entry portion of the service tap body, such that the internal surface is configured for operable engagement; (iii) engage at least a portion of an insert element, which is in operable communication with a sensing target element, with the internal surface of the service tap entry portion; (iv) locate the service tap connection point utilizing the sensing target element; and (v) at least partially engage a fitting device with the internal surface of the service tap entry portion, thereby providing fluid communication between the service tap passageway and the internal portion of the liner.

In a further embodiment, the present invention is also directed to an insert element. The insert element is used in connection with the tapping method. In one preferred and non-limiting embodiment, the insert element is configured for engagement with an internal surface of the service tap entry portion. The insert element is in operable communication with a sensing target element, and the sensing target element produces a recognizable signal. In one embodiment, the sensing target element is magnetic, and the produced recognizable signal is a magnetic wave.

The present invention is also directed to a fitting device. The fitting device is used in connection with the tapping method. In one preferred and non-limiting embodiment, the fitting device is configured to at least partially engage an internal surface of the service tap entry portion. Accordingly, the fitting device provides fluid communication between the service tap internal passageway and the internal portion of the liner. In one preferred and non-limiting embodiment, the fitting device includes a nipple element having an internal passageway for at least partially engaging the internal surface of the service tap entry portion, and a gasket element

surrounding at least a portion of the nipple element and abutting an internal wall of the liner. A locking means is engaged with the nipple element in order to urge the gasket element toward the internal wall of the liner.

The present invention, both as to its construction and its method of operation, together with the additional objects and advantages thereof, will best be understood from the following description of exemplary embodiments when read in connection with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a first step of a method for remotely and internally tapping a conduit according to the present invention;

FIG. 2 is a schematic view of a further step of the method for remotely and internally tapping a conduit according to the present invention;

FIG. 3 is a side sectional view of a swage sleeve of a fitting device according to the present invention;

FIG. 4 is a side sectional view of a swage spreader portion of the fitting device of FIG. 3;

FIG. 5 is a side sectional view of a fitting device engaged with a conduit and liner according to the method of the present invention;

FIG. 6 is a side view of a nipple element of a fitting device according to the present invention;

FIG. 7 is a top view of the nipple element of FIG. 6;

FIGS. 8(a)-8(e) are top and side views of various embodiments of a tool element according to the present invention;

FIG. 9 is a side sectional view of a further embodiment of a fitting device attached to a conduit and liner according to the method of the present invention;

FIGS. 10(a)-10(c) are top and side rear views of one embodiment of an insert element according to the present invention;

FIGS. 11(a)-11(b) are top and side views of a gasket element of a fitting device according to the present invention;

FIGS. 12(a)-12(b) are top and side views of a locking nut of a fitting device according to the present invention;

FIG. 13 is a side sectional view of a preferred embodiment of a fitting device engaged with a conduit and liner according to the method of the present invention;

FIG. 14 is a side sectional view of a further embodiment of a fitting device engaged with a conduit and liner according to the method of the present invention; and

FIG. 15 is a still further embodiment of a fitting device engaged with a conduit and liner according to the method of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

For purposes of the description hereinafter, the terms "upper", "lower", "right", "left", "vertical", "horizontal", "top", "bottom"; "lateral" and derivatives thereof shall relate to the invention as it is oriented in the drawing figures. However, it is to be understood that the invention may assume various alternative variations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the invention. Hence, specific dimensions and other physical characteristics related to the embodiments disclosed herein are not to be considered as limiting.

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The present invention is a method, system and apparatus for remotely and internally tapping a service tap connection point **100** on a conduit **102**. The method, system and apparatus is illustrated in various embodiments, together with various components and subcomponents of the system, in FIGS. 1-15. The present method, system and apparatus is particularly useful in connection with a host conduit lining process, wherein a host conduit is lined with a liner, e.g., a liner conduit, a liner bladder, a liner layer, a liner material, etc. The presently-invented method is performed, at least partially, by an automatic or robotic mechanism configured to effectively perform the tasks and various steps of the method.

The service tap connection point **100** includes a service tap body **104** with an entry portion **106** engaged with a conduit connection orifice **108**. Further, the service tap body **104** has a service tap internal passageway **110** extending therethrough. This service tap internal passageway **110** provides fluid communication between an internal portion **112** of the conduit **102** and the service tap internal passageway **110**.

The present method, system and apparatus, as discussed in detail hereinafter, is used for providing service tap fluid communication with an internal portion **114** of a liner **116**. As discussed hereinabove, when initially constructing a water main conduit in a trench, the conduit **102** is fitted with various service taps **118**, and these service taps **118** are used to draw water from the main conduit **102** and provide controlled flow through a service conduit or line (not shown). In the lining process, the liner **116** will block the service taps **118**. In normal operation, fluid, and typically water is capable of flowing from the internal portion **112** of the conduit **102**, through the service tap connection point **100**, specifically through the conduit connection orifice **108** and the service tap internal passageway **110**, and into a service line or a conduit for distribution.

In a preferred and non-limiting embodiment, the presently invented method includes the steps of lining the conduit **102** with a liner **116** and inserting an automatic mechanism **10** into the internal portion **114** of the liner **116**. The automatic mechanism **10** locates the service tap connection point **100** and engages a fitting device **12** with an internal surface **120** of the service tap entry portion **106**. In this manner, fluid communication is provided between the service tap internal passageway **110** and the internal portion **114** of the liner **116**.

It is envisioned that, prior to lining the conduit **102** with a liner **116**, the method further comprises the steps of inserting the automatic mechanism **10** into the internal portion **112** of the conduit **102**. Next, the automatic mechanism **10** locates the service tap connection point **100** and engages at least a portion of an insert element **14**, which is in operable communication with a sensing target element **16** with the internal surface **120** of the service tap entry portion **106**. Finally, the automatic mechanism **10** is removed from the conduit **102** prior to the lining process. In this embodiment, when the automatic mechanism **10** is reinserted into the lined conduit **102**, the automatic mechanism **10** is able to locate the service tap connection point **100** utilizing the sensing target element **16**.

Prior to engaging the insert element **14** and sensing target element **16** with the service tap entry portion **106**, the automatic mechanism **10** may also prepare the internal surface **120** of the entry portion **106** for engagement. Specifically, the service tap entry portion **106** of the service tap body **104** should be prepared such that the insert element **14** may be engaged therein. Such preparation may constitute preparing, cutting or grinding the internal surface **120** of the

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entry portion **106**, such as by placing threads, grooves, indentations or some mating surface thereon.

The sensing target element **16** may be positioned on, within or manufactured integrally with the insert element **14**, such that when the insert element **14** is engaged with the service tap entry portion **106**, the sensing target element **16** is aligned with a distal end **124** of the service tap entry portion **106**. It is envisioned that the sensing target element **16** may be any element whose location can be determined using communicating or sensing equipment. For example, the sensing target element **16** may be a magnet, and the automatic mechanism **10** may include components that can sense magnetic waves. However, the sensing target element **16** may be any target that emits signals that may be sensed, such as infrared, sonic, isotopic, radio, microwave and similar signals. After the lining process, and since the service tap connection point **100** will be covered, the automatic mechanism **10** uses the sensing target element **16** on the insert element **14** to locate the service tap entry portion **106**. In addition, the placement of the insert element **14** and sensing target element **16** at the service tap connection point **100** can be repeated for each and every service tap connection point **100** throughout and along the conduit **102** and conduit system. After each service tap connection point **100** is marked by the insert element **14**, thus making it locatable after the lining process, the automatic mechanism **10** is removed from the internal portion **112** of the conduit **102**.

After the liner **116** is appropriately installed in the conduit **102**, the automatic mechanism **10** is reinserted in the internal portion **114** of the liner **116** and locates the service tap connection point **100** using the sensing target element **16**. In one preferred and non-limiting embodiment, the insert element **14** and sensing target element **16** are removed prior to engagement of the fitting device **12** with the service tap entry portion **106**. Whether or not removed, the engagement and disengagement of the fitting device **12**, the insert element **14** and/or any of the other components or subcomponents of the system may be accomplished via the automatic mechanism **10**. Accordingly, the automatic mechanism **10** may be a robot, which is configured to travel within both the internal portion **112** of the conduit **102** and the internal portion **114** of the liner **116**. The modifications required to an automatic mechanism **10** to make it mobile within the conduit **102** or the liner **116** are known in the art, and may include such components as wheels, tracks, treads or other mobility-enabling structures or mechanisms. Further, the automatic mechanism **10** may include further components to achieve a variety of different functions and results within the internal portion **112** of the conduit **102** and the internal portion **114** of the liner **116**. For example, the automatic mechanism **10** may include a control mechanism **18** for controlling one or more of the components or subcomponents and operation of the automatic mechanism **10**. The automatic mechanism **10** may also include a user interface **20** that is in communication with a remote user control mechanism **22**. Such communication may be achieved through a variety of processors and signals as is known in the art. For example, the communication may be hard-wired or wireless, infrared, radio frequency, and/or other signal-based technologies as is known in the art.

The automatic mechanism **10** may also include one or more sensor mechanisms **24** to sense an operating parameter of the automatic mechanism **10** and/or a physical characteristic of a surrounding environment. For example, the sensor mechanism **24** may be capable of sensing the signals emanating from the sensing target element **16** for location of the service tap connection point **100**. The sensor mechanism

24 may also sense various system states and environmental states in the liner 116, the conduit 102, the service tap connection point 100 and surrounding areas. Still further, the sensor mechanism 24 may be used to receive, process and transmit various signals relating to the operation of the automatic mechanism 10 for maintenance, trouble shooting, operation and system efficiency improvement.

The automatic mechanism 10 may also include a camera mechanism 26 for providing visual feedback to the remote user control mechanism 22. In this manner, the user may visually inspect the process of operation of the automatic mechanism 10 as it travels through and functions within the internal portion 112 of the conduit 102 and the internal portion 114 of the liner 116. Further, the user may be able to control the automatic mechanism 10 using the visual feedback from the camera mechanism 26. It is also envisioned that the automatic mechanism 10 include a contact mechanism 28 capable of preparing a surface, boring an orifice, manipulating a component of the system, such as the fitting device 12, the insert element 14, the sensing target element 16, etc. For example, in one preferred and non-limiting embodiment, in order to effectively remove the insert element 14 and engage the fitting device 12 with the service tap entry portion 106, the automatic mechanism 10 may include appropriate components for boring an orifice through the liner 116 in order to provide fluid communication between the internal portion 114 of the liner 116 and the service tap connection point 100.

Returning to the method of the present invention, and as discussed above in connection with the automatic mechanism 10, fluid communication must be provided between the service tap connection point 100 and a service line, such that fluid material flows from the conduit 102 through the service tap connection point 100 and into the service line. After a lining process, an orifice must be bored in the liner 116, typically by the automatic mechanism 10, through a liner wall 126, such that the orifice is substantially in line with the service tap internal passageway 110. In this manner, fluid communication is provided between the internal portion 114 of the liner 116 and a service liner conduit via the service tap connection point 100.

As seen in FIG. 2, in one preferred and non-limiting embodiment, once the insert element 14 and sensing target element 16 are removed from the service tap connection point 100, and after the lining process, the fitting device 12 is engaged with the service tap entry portion 106. In this embodiment, the fitting device 12 includes a nipple element 30 having a nipple element internal passageway 32 extending therethrough. Specifically, the nipple element 30 is engaged with the service tap entry portion 106 through a variety of methods, as discussed hereinafter. In the embodiment illustrated in FIG. 2, a nipple element outer surface 34 includes threads capable of mating with a threaded portion of the service tap entry portion 106, and specifically the service tap internal passageway 110. At this point, the automatic mechanism 10 has already prepared the service tap internal passageway 110 for connection, such as by placing mating threads thereon. After the nipple element 30 is engaged with the service tap internal passageway 110 at the service tap entry portion 106, a gasket element 36 is fitted over a distal end of the nipple element 30 for sealing the conduit connection orifice 108 with respect to the internal portion 114 of the liner 116 and the nipple element 30 (excluding the intended fluid communication through the service tap internal passageway 110 of the nipple element 30). In particular, the gasket element 36 abuts the liner wall 126 in an area immediately adjacent the nipple element 30.

The gasket element 36 may also be attached to the liner 116 via an adhesive, glue, fusion, electrofusion, etc.

Finally, a locking means 38 is engaged with the nipple element 30 for urging the gasket element 36 against the liner wall 126. Accordingly, the nipple element 30 is engaged with the service tap entry portion 106 and sealed fluid communication is provided between the internal portion 114 of the liner 116 and the service tap internal passageway 110. In one preferred and non-limiting embodiment, the locking means 38 is a locking nut 40 capable of threadedly engaging the nipple element 30. Specifically, the locking nut 40 includes thread grooves capable of mating with the threads disposed on the nipple element outer surface 34.

Another preferred and non-limiting embodiment is illustrated in FIGS. 3-5. In this embodiment, the fitting device 12 includes a swage sleeve 42 positioned within and abutting the internal surface 120 of the service tap entry portion 106. The swage sleeve 42 includes a swage sleeve internal passageway 46 extending therethrough and having a tapered rim portion 48. In this embodiment, the nipple element 30 includes a swage spreader portion 50 having a neck portion 52 and a tapered rim portion 54 at an end thereof. The neck portion 52 is engaged within the swage sleeve internal passageway 46, such that the tapered rim portion 54 of the neck portion 52 is engaged with the tapered rim portion 48 of the swage sleeve 42.

As discussed above, a gasket element 36 is placed over and surrounds the nipple element 30, and the locking means 38, for example the locking nut 40, is engaged with the nipple element 30. When the locking nut 40 is engaged with the nipple element 30, the swage spreader portion 50 is pulled, thereby urging the swage sleeve outer surface 56 toward the internal surface 120 of the service tap entry portion 106 via the tapered rim portion 54 of the neck portion 52. In this manner, the nipple element 30 is effectively engaged within and sealed with respect to the service tap entry portion 106.

In order to engage the nipple element 30 with the service tap entry portion 106, the nipple element 30 may also include a nipple element engagement recess 58 and/or a nipple element engagement projection 60. Specifically, the nipple element engagement recess 58 and/or the nipple element engagement projection 60 would be positioned on the nipple element distal end 62 and configured for optimal engagement with a tool element 76. The tool element 76 includes one or more tool element engagement recesses 78 and one or more tool element engagement projections 80. Specifically, the tool element engagement recesses 78 are sized and shaped so as to mate with the nipple element engagement projections 60, while the tool element engagement projections 80 are sized and shaped so as to mate with the nipple element engagement recesses 58. Various embodiments of the tool element 76, together with the tool element engagement recesses 78 and the tool element engagement projections 80 are illustrated in FIGS. 8(a)-8(e). Accordingly, when the tool element 76 is engaged with the nipple element 30 via the nipple element engagement recess 58 or nipple element engagement projection 60, and when the tool element 76 is rotated, the nipple element 30 is correspondingly rotated. Accordingly, the tool element 76 includes a surface capable of mating with the nipple element engagement recess 58 and/or the nipple element engagement projection 60. Still further, the tool element 76 can be positioned on the automatic mechanism 10 in order to allow the automatic mechanism 10 to perform the engaging function. One embodiment of the nipple element 30, including

the nipple element engagement recess **58** and/or the nipple element engagement projection **60**, is illustrated in FIGS. **6-7**.

Another preferred and non-limiting embodiment of the present invention is illustrated in FIG. **9**. As seen in this embodiment, while the sensing target element **16** is removed after location of the service tap connection point **100**, the insert element **14** remains engaged with and abutting the service tap entry portion **106**. Specifically, the insert element **14** remains in place while the fitting device **12** is engaged with the service tap entry portion **106** for providing an additional engagement surface and sealing function. Such an arrangement may be preferable to attain better sealing between the service tap entry portion **106** and the conduit connection orifice **108** on the conduit **102**.

One preferred embodiment of the insert element **14** is illustrated in FIG. **10**. As seen in this embodiment, the insert element **14** includes an insert element orifice **64** and an insert element rim portion **66**. Accordingly, the sensing target element **16** may be positioned within the insert element orifice **64** and abutting the insert element rim portion **66**. However, as discussed above, if the insert element **14** is to be left in the engaged relationship while the sensing target element **16** is removed, the insert element orifice **64** still allows fluid communication between the internal portion **112** of the conduit **102** and the service tap connection point **100**. A preferred embodiment of the gasket element **36** is illustrated in FIG. **11**. The gasket element **36** includes a rounded face **68** formed to appropriately contact and seal against the liner wall **126**, which is also rounded. Further, one preferred embodiment of the locking nut **40** is illustrated in FIG. **12**, wherein the locking nut **40** is a hexagonal structure.

Multiple envisioned fittings, systems and apparatus for the fitting device **12** are illustrated in FIGS. **13-15**. In FIG. **13**, the above-discussed threaded nipple element **30** configuration is utilized. In the embodiment of FIG. **13**, the insert element **14** is left in place, and the gasket element **36** is not used. Instead, the locking means **38** surrounds and seals the nipple element **30** with respect to the liner wall **126**. For example, the locking means **38** may be a locking nut **40** that is either constructed from or coated with a material that allows for a sealing relationship between the nipple element **30** and the liner wall **126**. Further, the locking nut **40** may be sized and shaped as to mate with the liner wall **126**.

In the embodiment illustrated in FIG. **14**, the fitting device **12** includes a nipple element **30** having an expandable portion **70** with a rim portion **72** positioned on the expandable portion **70**. Either the locking means **38**, such as the locking nut **40**, or a further shafted element is engaged with the nipple element **30**. This forces a wall **74** of the expandable portion **70** outward and in a contacting/engaging relationship with the internal surface **120** of the service tap entry portion **106**, specifically with the rim portion **72** of the nipple element **30** engaging against the internal surface **120**.

A further embodiment of the fitting device **12** is illustrated in FIG. **15**. In this embodiment, the nipple element **30** does not include threads, and instead is sized and shaped so as to be frictionally engaged within the service tap internal passageway **110** at the service tap entry portion **106**. In particular, the nipple element **30** and the locking means **38** may constitute the same structure, with the nipple element internal passageway **32** extending through both the nipple element **30** and the locking means **38**. In order to provide the engagement, the nipple element **30** and/or the locking means **38** may be beveled, tapered, etc. Further, any of the various components discussed above in connection with the fitting

device **12** and/or the insert element **14** may be manufactured from or coated with a material that provides a sealing relationship with a mating surface, for example rubber, a polymer or the like.

The automatic mechanism **10** performs the vast majority of the functions and steps of the presently-invented method. For example, the automatic mechanism **10** or robot may locate the service tap connection point **100**, ream or prepare the service tap entry portion **106**, perform facing operations, tap or cut threads, force fit the apparatus, provide visual or other similar feedback to a user, etc. In this manner, the present invention provides a remote tapping method, system and apparatus for internally tapping a conduit **102** for providing fluid communication between the internal portion **114** of the liner **116**, through the service tap connection point **100** and into a service line. The present invention eliminates the need for excavating a buried conduit **102** in order to position and reestablish service tap connection points **100**. Further, the present invention utilizes the automatic mechanism **10** to locate, prepare and reestablish a service tap connection point **100** from within the conduit **102**.

This invention has been described with reference to the preferred embodiments. Obvious modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations.

What is claimed is:

**1.** A method for remotely tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the method comprising:

inserting an automatic mechanism into the internal portion of the conduit, wherein the automatic mechanism:

- (i) locates the service tap connection point on the conduit; and
- (ii) engages at least a portion of an insert element, which is in operable communication with a sensing target element, with the internal surface of the service tap entry portion;

removing the automatic mechanism from the conduit lining the conduit with a liner; and

inserting the automatic mechanism into an internal portion of the liner, wherein the automatic mechanism:

- (i) locates the service tap connection point; and
- (ii) at least partially engages a fitting device with the internal surface of the service tap entry portion, thereby providing fluid communication between the service tap internal passageway and the internal portion of the liner.

**2.** The method of claim **1**, wherein the automatic mechanism locates the service tap connection point utilizing the sensing target element.

**3.** The method of claim **1**, wherein the automatic mechanism prepares an internal surface of a service tap entry portion of the service tap body, such that the internal surface is configured for operable engagement.

**4.** The method of claim **3**, wherein the preparation step further comprises placing at least one of threads, grooves, indentations and a mating surface on the internal surface of the service tap entry portion.

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5. The method of claim 1, wherein the sensing target element is at least one of positioned on, within and integral with the insert element.

6. The method of claim 1, further comprising positioning the sensing target element near a distal end of the service tap entry portion.

7. The method of claim 1, wherein the sensing target element is magnetic and configured to project magnetic waves therefrom.

8. The method of claim 1, further comprising removing at least one of the insert element and the sensing target element prior to step (b)(ii).

9. The method of claim 1, further comprising repeating at least one of step (b)(i) and (b)(ii) for a subsequent one of a plurality of service tap connection points.

10. The method of claim 1, further comprising removing the automatic mechanism from the internal portion of the liner.

11. The method of claim 1, wherein the automatic mechanism is a robot configured to travel within at least one of the internal portion of the conduit and the internal portion of the liner.

12. The method of claim 1, further comprising providing fluid communication between the service tap connection point and a service line, such that fluid material flows from the conduit to the service line.

13. The method of claim 1, further comprising boring an orifice, by the automatic mechanism, through a wall of the liner, such that the liner orifice is substantially in line with the service tap internal passageway.

14. The method of claim 1, wherein the fitting device comprises a nipple element having an internal passageway, wherein step (b)(ii) further comprises frictionally engaging the nipple element with at least a portion of the internal surface of the service tap entry portion.

15. The method of claim 14, further comprising engaging the nipple element with the internal surface of the service tap entry portion by a tool element.

16. The method of claim 15, wherein the tool element is positioned on the automatic mechanism.

17. A method for remotely tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the method comprising:

lining the conduit with a liner; and

inserting an automatic mechanism into an internal portion of the liner, wherein the automatic mechanism:

(i) locates the service tap connection point; and

(ii) at least partially engages a fitting device with the internal surface of the service tap entry portion, thereby providing fluid communication between the service tap internal passageway and the internal portion of the liner;

wherein the automatic mechanism comprises at least one of:

(i) a control mechanism configured to control at least one of a component and operation of the automatic mechanism;

(ii) a user interface configured to communicate with a remote user control mechanism;

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(iii) at least one sensor mechanism to sense at least one of an operating parameter of the automatic mechanism and a physical characteristic of a surrounding environment;

(iv) a camera mechanism configured to provide visual feedback to a remote user control mechanism; and

(v) a contact mechanism configured to at least one of prepare a surface for engagement, bore an orifice and manipulate a component.

18. A method for remotely tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the method comprising:

a. lining the conduit with a liner; and

b. inserting an automatic mechanism into an internal portion of the liner, wherein the automatic mechanism:

(i) locates the service tap connection point; and

(ii) at least partially engages a fitting device with the internal surface of the service tap entry portion, thereby providing fluid communication between the service tap internal passageway and the internal portion of the liner;

wherein step (b)(ii) further comprises:

at least partially engaging a nipple element having an internal passageway with the internal surface of the service tap entry portion; and

engaging a locking means with the nipple element, thereby sealing the nipple element with respect to an internal wall of the liner.

19. The method of claim 18, wherein prior to engaging the locking means, the method further comprises positioning a gasket element around at least a portion of the nipple element in an abutting relationship with an internal wall of the liner, such that the locking means urges the gasket element against the internal wall of the liner.

20. The method of claim 18, wherein the locking means is a locking nut configured to threadedly engage a distal end of the nipple element.

21. The method of claim 18, further comprising:

positioning a swage sleeve within and abutting the internal surface of at least a portion of the service tap entry portion, the swage sleeve including an internal passageway extending therethrough and a tapered rim portion, wherein the nipple element further includes a swage spreader portion having a neck portion with a tapered rim portion at an end thereof;

at least partially engaging the neck portion within the internal passageway of the swage sleeve, such that the tapered rim portion of the neck portion is engaged with the tapered rim portion of the swage sleeve;

engaging the locking means with the nipple element;

pulling the swage spreader portion through the engagement of the locking means and the nipple element; and urging an outer surface of the swage sleeve towards the internal surface of the service tap entry portion by the tapered rim portion of the neck portion.

22. The method of claim 18, wherein the nipple element further includes at least one of an engagement recess and an engagement projection positioned on a portion of the nipple element, the at least one engagement recess and engagement projection configured for operable engagement with a tool element, whereby, when the tool element is rotated, the nipple element is correspondingly rotated.

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23. The method of claim 22, further comprising positioning the tool element on the automatic mechanism.

24. The method of claim 18, wherein the nipple element further includes an expandable portion with a rim portion positioned on the expandable portion, the method further including:

- engaging the locking means with the nipple element;
- forcing the wall of the expandable portion outward through the engagement of the locking means with the nipple element; and
- contacting and engaging the rim portion with the internal surface of the service tap entry portion.

25. An automatic mechanism for remotely tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the automatic mechanism configured to at least one of:

- (i) locate the service tap connection point on the conduit;
- (ii) prepare an internal surface of a service tap entry portion of the service tap body, such that the internal surface is configured for operable engagement;
- (iii) engage at least a portion of an insert element, which is in operable communication with a sensing target element, with the internal surface of the service tap entry portion;
- (iv) locate the service tap connection point utilizing the sensing target element; and
- (v) at least partially engage a fitting device with the internal surface of the service tap entry portion, thereby providing fluid communication between the service tap passageway and the internal portion of the liner.

26. The automatic mechanism of claim 25, wherein the automatic mechanism is a robot configured to travel within at least one of the internal portion of the conduit and the internal portion of the liner.

27. The automatic mechanism of claim 25, wherein the automatic mechanism further comprises at least one of:

- (i) a control mechanism configured to control at least one of a component and operation of the automatic mechanism;
- (ii) a user interface configured to communicate with a remote user control mechanism;
- (iii) at least one sensor mechanism to sense at least one of an operating parameter of the automatic mechanism and a physical characteristic of a surrounding environment;
- (iv) a camera mechanism configured to provide visual feedback to a remote user control mechanism; and
- (v) a contact mechanism configured to at least one of prepare a surface for engagement, bore an orifice and manipulate a component.

28. An insert element for use in connection with tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the insert element configured for engagement with an internal surface of the service tap entry portion, wherein the insert element is in operable communication with a sensing target element configured to produce a recognizable signal.

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29. The insert element of claim 28, wherein the sensing target element is at least one of positioned on, within and integral with the insert element.

30. The insert element of claim 28, wherein the sensing target element is positioned near a distal end of the insert element.

31. The insert element of claim 28, wherein the sensing target element is magnetic and the produced recognizable signal is a magnetic wave.

32. A fitting device for use in connection with tapping at least one service tap connection point on a conduit, the connection point having a service tap body with an entry portion engaged with a conduit connection orifice and a service tap internal passageway extending through the service tap body for providing fluid communication between an internal portion of the conduit and the service tap internal passageway, the fitting device configured to at least partially engage an internal surface of the service tap entry portion, thereby providing fluid communication between the service tap passageway and the internal portion of the liner, wherein the fitting device further comprises a nipple element having an internal passageway configured to at least partially engage the internal surface of the service tap entry portion; and a locking means engaged with the nipple element for sealing the nipple element with respect to an internal wall of the liner.

33. The fitting device of claim 32, further comprising a gasket element positioned around at least a portion of the nipple element and in an abutting relationship with an internal wall of the liner, such that the locking means urges the gasket element against the internal wall of the liner.

34. The fitting device of claim 32, wherein the locking means is a locking nut configured to threadedly engage a distal end of the nipple element.

35. The fitting device of claim 32, wherein the fitting device further comprises:

a swage sleeve positioned within and abutting the internal surface of at least a portion of the service tap entry portion, the swage sleeve including an internal passageway extending therethrough and a tapered rim portion;

wherein the nipple element further includes a swage spreader portion having a neck portion with a tapered rim portion at an end thereof, the neck portion configured to be engaged at least partially within the internal passageway of the swage sleeve, the tapered rim portion of the neck portion engaged with the tapered rim portion of the swage sleeve;

wherein, when the locking means is engaged with the nipple element, the swage spreader portion is pulled, with the rim portion of the neck portion urging an outer surface of the swage sleeve towards the internal surface of the service tap entry portion.

36. The fitting device of claim 32, wherein the nipple element further includes at least one of an engagement recess and an engagement projection positioned on a portion of the nipple element, the at least one engagement recess and engagement projection configured for operable engagement with a tool element, whereby, when the tool element is rotated, the nipple element is correspondingly rotated.

37. The fitting device of claim 36, wherein the tool element is positioned on an automatic mechanism.

38. The fitting device of claim 32, wherein the nipple element further includes an expandable portion with a rim portion positioned on the expandable portion, such that when the locking means is engaged with the nipple element, the wall of the expandable portion is forced outward,



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whereby the rim portion contacts and engages the internal surface of the service tap entry portion.

**39.** The fitting device of claim **32**, further comprising a nipple element having an internal passageway configured to frictionally engage at least a portion of the internal surface of the service tap entry portion.

**40.** The fitting device of claim **39**, wherein the nipple element further comprises an engagement surface config-

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ured for operable engagement with a tool element, whereby, when the tool element is actuated, the nipple element is engaged with the internal surface of the service tap entry portion.

**41.** The fitting device of claim **40**, wherein the tool element is positioned on an automatic mechanism.

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